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SOME ASPECTS OF THE BIOLOGY AND ECOLOGY OF NARCONDAM HORNBILL (*RHYTICEROS NARCONDAMI*)[1]

S. A. Hussain[2]

(*With one coloured & five Black-and-White plates and five text-figures*)

Introduction

Two species of hornbills of the genus *Rhyticeros* are represented in the Indian sub-continent. Of these *R. undulatus* occurs in north-eastern India, Burma down to Malay peninsula and the Mergui Archipelago. The other, *R. narcondami* is restricted to Narcondam, an off lying island in the Andaman group. Very little is known about the biology and ecology of the latter. Hume (1873) on an expedition to the Andaman group collected several hornbills from Narcondam and named it *narcondami*. Prain (1893), St. John (1898), Cory (1902) and Osmaston (1905) visited Narcondam subsequently to collect specimens. The last spent five days, (the longest period of time spent in the island by a visitor), in search of stands of the timber tree *Pterocarpus dalbergoides*. He also made some notes on the fauna and flora including Hornbills, whose number he estimated to be about 200. No further information on the hornbills was available until two of my colleagues at the BNHS, Robert B. Grubh and R. J. Pimento visited the island briefly in 1969. Abdulali (1971) visited the island in the following year and spent a few hours to collect specimens. In 1972 along with Mr. N. J. George of Prince of Wales Museum, I visited the island at the instance and direction of Mr. Humayun Abdulali. We visited South and North Andamans and Narcondam island from 4th March to 25th April 1972 and the field data and specimens collected by us were reported in the *Journal* (Abdulali 1974). The Narcondam island (the name Narcondam is derived from Sanskrit *Naraka* — Hell; *Kundam* — Pit, — an obvious reference to the origin of the island which is believed to have been an active volcano not long ago) is difficult to approach, except during the months of March, April

[1] Accepted January 1984.

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and May when the sea around is comparatively calm.

The present paper records observations made by me during my stay on Narcondam from 16th March to 14th April 1972, and the subsequent observations on the two hornbill chicks brought back which lived in captivity at the Society's premises.

Taxonomical notes:

Hume (1873) while describing *narcondami* stated that it resembled *R. plicatus* of Borneo and due to the difference in size as well as the absence of a zoogeographic connecting link between these species gave the former the status of a species. Baker (1927) treated it as a full species in the absence of intermediates and stated that systematists may consider it to be a small island race of *R. plicatus* of which *R. everetti* of the Moluccas was thought to be an intermediate form. Blyth (1845) had in the meantime, described *subruficollis* from N Burma, which he differentiated from *R. plicatus ruficollis* by the absence of any ridges on the sides of bill and by its smaller size. Peters (1945) accepted this nomenclature and considered *subruficollis* a valid race of *plicatus*. Sanft (1960) who has authoritatively reviewed the family Bucerotidae, did not accept *subruficollis* as a race of *plicatus* preferring to synonymise it with *undulatus*. His argument was that *undulatus* and *subruficollis* are from the same ancestral stock, differing only in developmental stages as well as localised variations. One of the main differences is in the structure of the bill i.e. presence of ridges on the side of the basal half of the bill (= *undulatus*) and absence of it (= *subruficollis*), which according to him, are linked with sexual maturity and tend to develop as the bird becomes older. The difference in body size, according to him, was ecologically linked to the types of habitats in which they occur. Thus the larger birds of the mountainous region are *undulatus* and the smaller occurring in low hill zones *subruficollis*. However, he had overlooked two other distinct characteristics that differentiate the two. The colour pattern of the head and neck of males, colour of gular pouch, and presence or absence of a black band on throat. These patterns are apparently not linked with ecological distribution. Are they then linked with age? Does the yellow colour of gular pouch in ♂ and black band on the pouch in both female and male develop as they grow older ?[3] (Table 1).

A 16 year old specimen of *R. p. subruficollis* at the San Diego zoo shows all the characteristics of the typical *ruficollis* with blue gular pouch without the black band (K. C. Lint, pers. comm.). Under these circumstances the taxonomic and zoogeographic position of *narcondami* is quite intriguing. If one were to accept Sanft's proposition, *narcondami is a* smaller form showing immature characters of *undulatus* isolated in the islands long ago and gradually evolving into the present form (endemic ?) and in the process losing the adult characteristics of the *undulatus*. On the other hand, the *plicatus* link theory, with the recognition of *subruficollis* as a distinct subspecies of the former, would perhaps open up a new line of possibilities on the zoogeography of the region. Another species which perhaps raises

[3] Sanft, (IBIS 95: 702-703) after studying 16 museum specimens of *R. undulatus, R. subruficollis* and intermediates argued that the ranges of the two overlap with the intermediates showing characteristics of the both, and therefore *subruficollis* is synonymous with *undulatus*. However, Elbel (*Condor* 71 (4): 434-435) on the evidence of the mellophaga present in the above two species concluded that *subruficollis* is distinct from *undulatus* and is closer to *plicatus*.

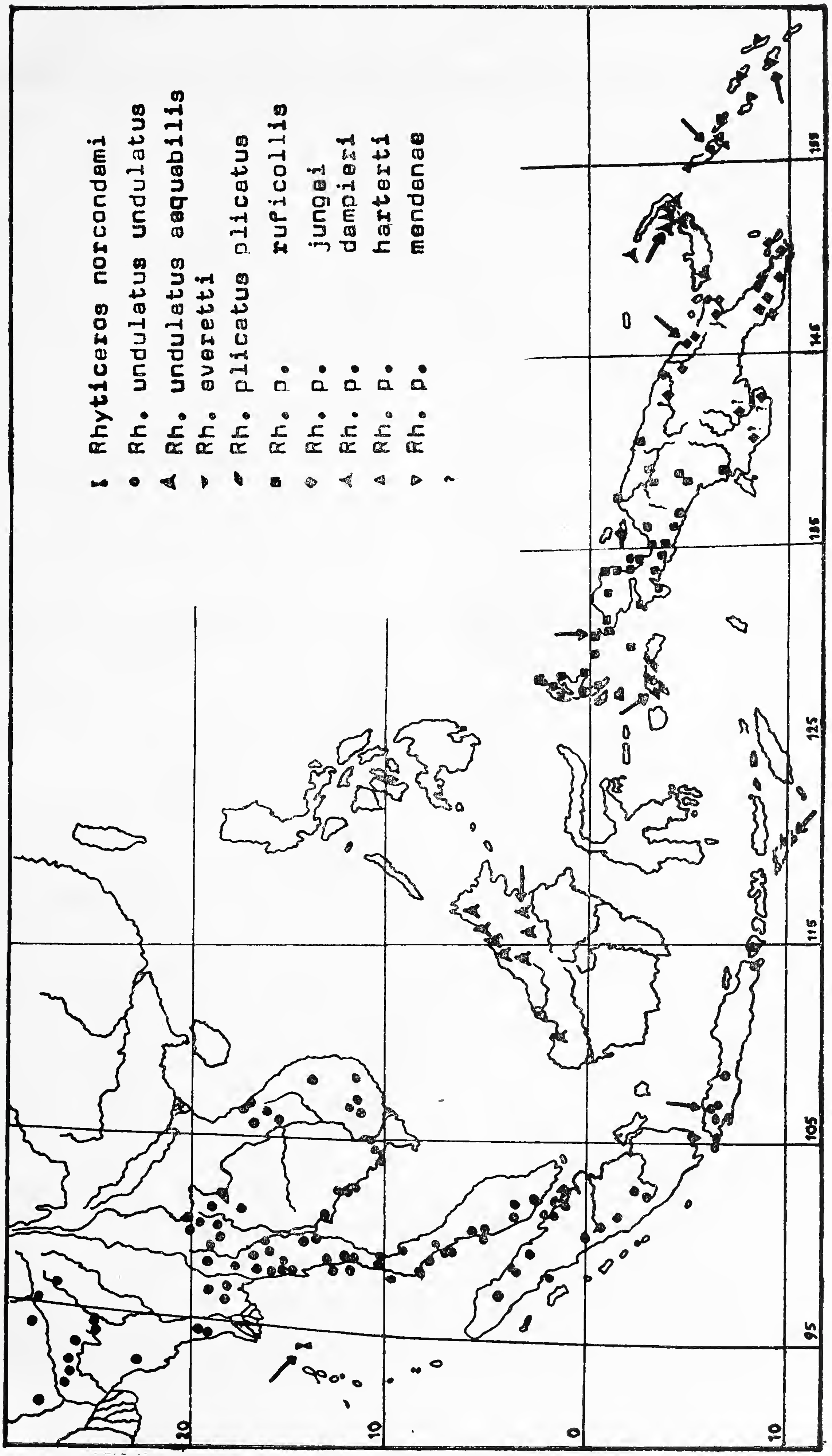


Fig. 1. Distribution of Hornbills in SE Asia (After Sanft 1960).

TABLE 1

	R. undulatus	*R. p. subruficollis*	*R. narcondami*
Bill :	Side of mandibles ridged at base	side of mandibles smooth at base	side of mandibles smooth at base
Wing :	458-505 ♂ ♀	420-445 ♂ ♀	303-305 ♂ 285-287 ♀
Weight :	2,500 gm	1,900 gm	6C0-750 gm
Head & Neck :	♂ dark brown crown and hindneck-almost black lower down. Throat & upper neck whitish	♂ rufous head & hind neck, white on throat	♂ rufous head and neck
Gular pouch :	Bright yellow with black band ♂ Dark blue and black band ♀	Pale blue ♂ ♀ Without black band	Pale blue ♂ ♀ without black band
Distribution :	NE India, Burma, Singapore, Sumatra, Java & Borneo	S. Burma, SW Thailand Sumatra, Borneo	Narcondam I.

similar questions is *R. everetti* an endemic of Sumba islands, SE Asia (Fig. 1). There are similarities in the evolution of these two species. Both are endemic to small islands, are smaller versions of neighbouring forms, and have distinct morphological characters (Fig. 2). Ali and Ripley (1970), followed Peters' nomenclature and called it *R.* (*undulatus*) *narcondami*. However, Ripley (1982) after seeing the live specimens in the BNHS and personal discussions with me agreed that *narcondami* is closer to *plicatus* than *undulatus*. Kemp and Kemp (1975) mention the long-hop flights of the SE Asian hornbills which sometimes cross the sea to offshore islands. These hornbills have been observed to take off from the mainland and fly in "follow the leader" formation for some distance straight out over the sea and return eventually to the starting point. Is this behaviour then an instinctive urge of a long forgotten "migratory" habit? The significance of the white tail in these hornbills which can be seen from long distances and which may probably act as a visual stimulus for the following hornbills, is worth noting.

Physiography and vegetation:

Narcondam island (13°30′ N; 94°38′ E) is situated *c* 500 km NW off Mergui archipelago and *c* 300 km SW of the Gulf of Martaban off the Burmese mainland, and *c* 125 km east of North Andaman in the Andaman and Nicobar group of islands in the Bay of Bengal. The island has a total area of about 682 hectares and is a part of a submerged chain of mountains in the Andaman archipelago. Narcondam is one of the two off-lying volcanic islands in the eastern sector of the group. It rises abruptly from the sea to a height of *c* 750 m sloping west-eastwards with a succession of steep spurs emanating from the main summit which is situated on the western portion of the island. The very mountainous nature of island (there

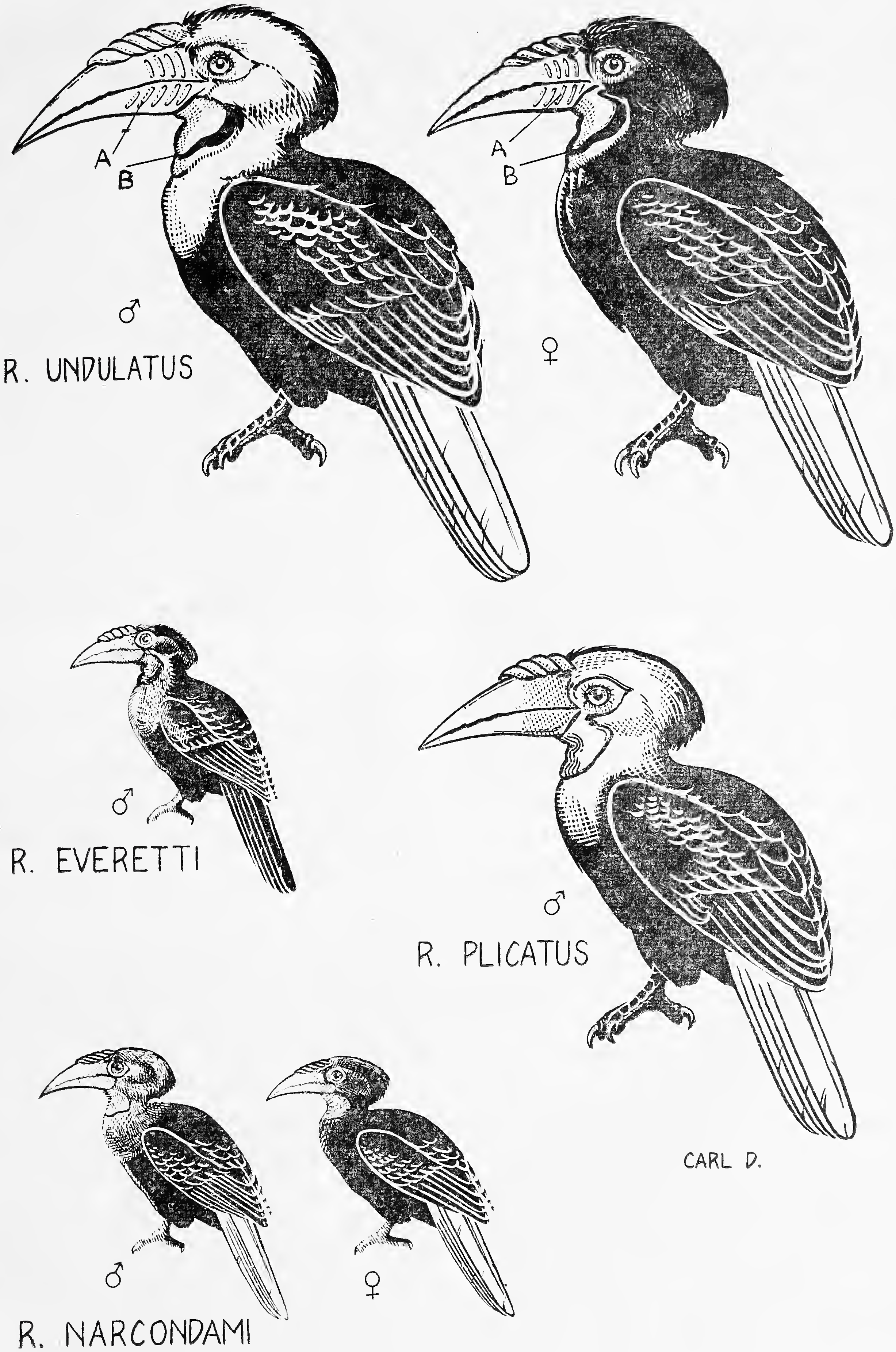


Fig. 2. Ridges and gular black band is absent in *plicatus plicatus*, *everetti everetti* and *narcondami*. Latter two are 1/3 the size of *undulatus* with *plicatus* being intermediate (*see* text).
Abbreviations: A — Ridges; B — Black band.

is virtually no continental shelf around the island) provides no landing place except for a small boulder-strewn bay on the southern side, which also provides the only small flat bit of ground for camping. A small spring in the bed of a dry nallah about 25 m above the sea level is the only fresh water source in the island known so far.

Climate:

The climate of the Andaman group of islands is tropical wet and humid with daily temperatures ranging from 27.8°C maximum and 21.8°C minimum. The rainfall is heavy both during SW and NE monsoons, lasting from May to October. Cyclonic storms occur during this period with rough weather conditions prevailing almost throughout the season. The average annual rainfall recorded for 17 years at Mayabunder (12°55′ N; 92°55′ E) the nearest weather station to Narcondam, is 3055.5 mm with an average of 13.4 rainy days per year. The month of July recorded highest average (538.5 m / 18.7 rainy days) and March lowest (4.8 mm / 0.4 rainy days).

Vegetation:

Parkinson (1923) and Thothathri (1960, 1962), and Balakrishnan (?) give some details of the flora of the Andaman and Nicobar group of islands. Prain (1893) described some aspects of the flora of Narcondam. The vegetation structure of the Narcondam island is more or less similar to that of the tropical N Andaman group. The vegetation can be divided into three categories (a) littoral (b) deciduous/evergreen and (c) moist evergreen. The very limited 'shoreline' of the island contains *Ipomoea biloba, Scaevola koenigi, Hibiscus tiliaceus, Pandanus* sp., *Thespesia populnea, Barringtonia speciosa* and *Sterculia rubiginosa*. Introduced plants like Coconut, Papaya and Banana grow wild in this zone. The lower hills immediately following the 'shoreline' have both deciduous and evergreen trees. Some of the typical plants of this zone are *Terminalia catappa, T. bialata, Parishia insignis,* and *Caryota mitis* interspersed with numerous thorny creepers. The flora in the higher zones of the hill contains evergreens like *Dipterocarpus* sp., *Sideroxylon* sp., *Ficus* sp. etc. The vegetation still higher and close to the summit appears to be moist evergreen, with numerous epiphytes. Some of the seeds collected from a hornbill's nest were later identified as *Anamirta cocculus, Capparis sepiaria, C. tenera* var. *latifolia, Garuga pinnata, Amoora rohituka, Terminalia catappa* and *Ixora brunniscens*. Apart from these, several other fruiting trees including the ones mentioned above no doubt occur in the island.

Mammals:

No large mammals have been recorded in the island. Large rats (*Rattus* sp.) obviously introduced, are common around the landing bay. Giant fruit bats (*Pteropus melanotus satyrus*) are common and other smaller bats may also occur.

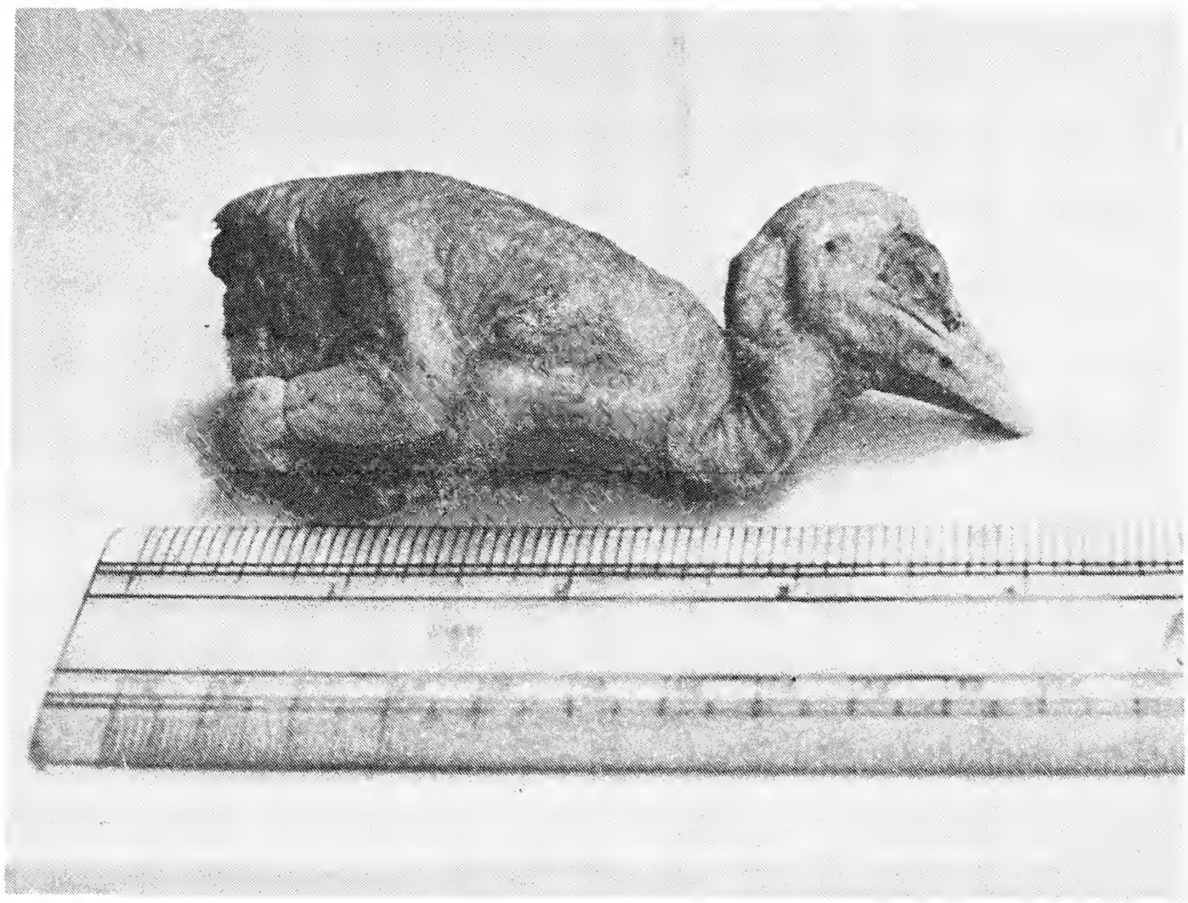
Reptiles:

One of the commonest snakes seen in the island is the flying snake *Chrysopelia paradisi* which is mostly arboreal. On the seashore occasionally sea snakes *Laticauda colubrina* are encountered. The giant water monitor *Varanus salvator* is common in different parts of the island. One specimen, which was collected, measured 1 m and weighed 4.5 kg. Skinks, *Mabuya tytleri, Lygosoma maculatus* and lizards, *Cnemaspis kandiana, Cyrtodactylus rubidus* and *Phelsuma andamanense* (endemic to Andamans) are common.

Land Crabs (*Cardisoma hirtipes*) are very

Above: Narcondam island from western side. The central peak is perpetually under a shroud of cloud.
Below: Male feeding female (and young) at nest 'B'.

(*Photos*: Pat Louis)



Above: Debris from nest 'A' (27/3/1972).
Below: A week old chick from nest (27/3/1972).
(*Photos*: S. A. Hussain)

common throughout the island, occuring even higher up in the hills. Of the invertebrates, Danaidae; Nymphalidae; Lycaenidae (Butterflies); *Chryoschroa ignita, Mimila prenceps* (Beetles); and spiders of the families Heteropidae, Aregiopidae, and Thomsidae are recorded.

Results

An attempt was made to locate as many nests of the hornbill as possible and to census the population. A regular count of all the hornbills seen each day was made (see table 2). Increase in number of the females sighted may be due to their emergence from nest confinement after a successful brooding. It was not possible to identify all the nesting trees though a few nests were spotted on *Sideroxylon* sp. and *Sterculia* sp. Most of the nests were discovered from the debris and excreta and seeds below the nest-trees while a few others by observing the movements of the male bringing food to the nest.

Table 2

NARCONDAM HORNBILL

Date	No. of ♂ seen	No. of ♀ seen	No. of nests	No. of ♂ ♀ at nest
17/iii/76	25	Nil	3	3(♂)
18	19	Nil	Nil	—
19	26	Nil	2	2(♂)
20	14	Nil	Nil	—
21	28	1 (with ♂)	Nil	—
22	31	4 (2 with ♂)	Nil	—
23	8	Nil	Nil	—
24	11	4	1	—
25	16	2	Nil	—
26	14	3	1	1(♂)
27	19	4 (2 with ♂)	Nil	—
28	16	2	1	1(♂)
29	59	11	Nil	—
30	72	28	1	—
31	40	10	—	—
1/iv/'76	31	9	—	—
2	59	14	—	—
3	13	2	—	—
4	42	12	—	—
5	39	11	—	—
6	21	8	—	—
7*	—	—	—	—
8	48	9	—	—
9	23	4	—	—
10	52	11	—	—

* Rain

Note: The birds were counted randomly each day. The numbers may be biased on certain days as the birds congregating in feeding trees were counted as well as males on feeding forays may have been counted several times over!

Fig. 3. Nest 'A' sketch.

Nesting site:

A rough estimate of the heights of the nests observed varied between 2.4 m to 15.2 m. Two nests situated at 2.5 m and 2.74 m respectively were studied in detail. The nest 'A' (Fig. 3) was situated on the outer bend of one of the main boughs of a tree facing west. The entrance, though not concealed, was not easy to spot as the ground below the nest sloped downwards steeply. The outer rim of the hole breadthwise measured 30 cm. Depth from the entrance to inner wall about 180 cm gradually tapering inwards. Nest 'B' (Plate I) was on a bare tree facing east situated about 22.9 m from nest 'A'. The ground rose into a steep ascent in front of the nest which enabled one to gaze directly into the nest hole from a certain height. The entrance measured about 25 cm with a depth of about 149 cm. The flooor of the nest was horizontal. The contents removed from nest 'A' weighed 1360 g and consisted of eight varieties of seeds apart from feathers and powdered plaster. Some of the seeds were identified by the Botanical Survey of India.

The female and the young in the nest sat with their tail held up vertically. (They continued to remain in this posture for quite some time even after they were removed from the nest.) The female attended to nest sanitation after every feeding visit of the male. She was observed tossing out what appeared to be the excreta of the young with her beak while she herself turned around and forcibly ejected her own excreta. On 6th April one of the chicks in the nest 'B' was seen making feeble attempts to defecate by bringing the anal region towards the nest entrance. Thereafter both the chicks regularly defecated in this manner.

Behaviour at nest:

The male starts fetching the food just before sunrise. No marked territorial behaviour by the breeding pair was observed. Occasionally an alien male or female was tolerated in the vicinity of the nest (i.e. on the same tree) though the minimum distance measured between two nests was about 22.8 m. Frequency of feeding varies with distance covered to the foraging tree. The shortest time recorded was 10 minutes and the longest 30 minutes. On arrival the male always perched on a particular branch of a tree depending on the direction of his arrival. If undisturbed, he would fly directly to the nest-hole, perching on a convenient branch or clinging to the nest itself and proceed feeding the female. The food is coughed up, brought to the tip of the beak which is inserted into the slit opening and is offered to the female. The number of the insertions depends on the size of the food brought in. Large berries are offered piecemeal while smaller ones, whole. No attempt was made to retrieve the food that fell down in the course of feeding. A minimum of 10 insertions were counted when berries offered were large and a maximum of 93 when they were smaller. Some times the insertions are 'false' when the female is not ready to receive the next berry. (Is she in turn feeding the young?) All this time the young would keep calling continuously. Once the feeding was over the male would clean his beak on the branch a few times and after preening himself for a while fly away on the next foraging trip.

In the beginning of my observations the male refused to approach the nest in my presence. He kept flitting from branch to branch and finally flew away. He seemed to rely on sight and showed no reactions to normal sounds but was wary of human voice. This particular male did not allow me to observe from any position *below* the line of its nest but allowed me to remain in full view at a dis-

tance of about 13.7 m, *above* the line of its nest. (This was possible as the ground rose upwards from the nesting tree).

It was not possible to ascertain the roles of the male and the female in nest building. The female in the nest 'A' was seen tamping the plaster of her nest by applying material with the sides of her bill on 18th March. The female sheds her flight feathers in the nest. The female taken out of the nest 'A' had 3rd, 4th and 5th primaries on the left wing and 3rd, 4th, 5th and 6th on the right in moult. The rest had fallen. Of the tail the 3rd pair was in moult. She weighed about 680 g, while the bill measured 108 mm, tarsus 43 mm, tail 198 mm, (moulting). She was found to be incapable of flight.

General behaviour

Call :

In flight, adults of both sexes emit a continuous 'Ka .. ka .. ka' to the accompaniment of wheezing laboured wingbeat. When alarmed, the male at nest-site calls a halting 'ko .. kokokoko .. ko .. kok .. ko kok kok kok' etc. The female inside the nest is generally silent, but sometimes utters a single 'krwak' if the male is late in offering the next morsel during the course of a feeding. If alarmed herself she emits a repeated 'Kraawk kok kok' resembling the alarm call of a frightened domestic fowl. The young inside the nest call feebly 'chew . . . chew . . . chew' continuously like a squeaking sewing machine in operation, especially when the male is feeding.

Courtship :

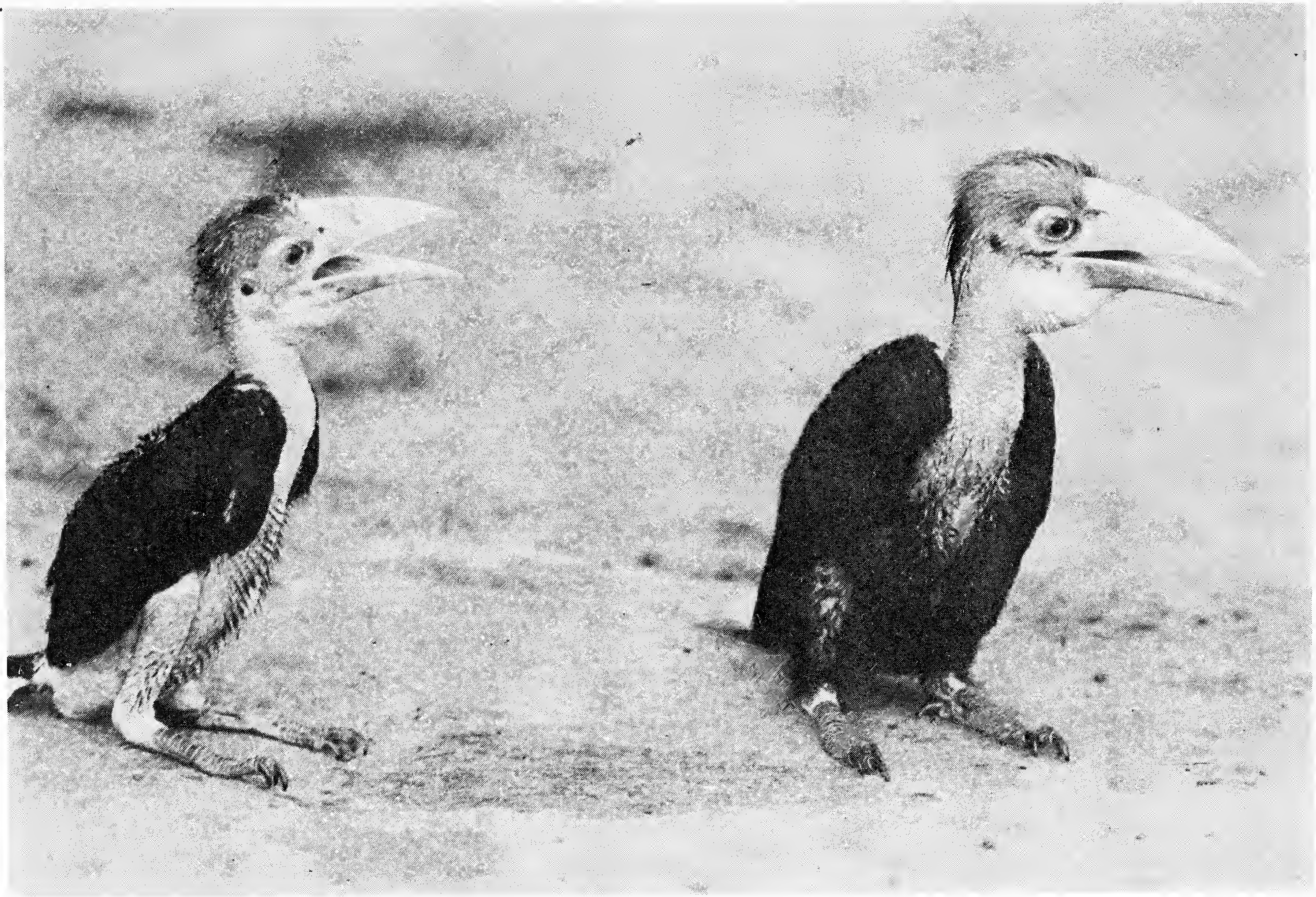
On 27th March four males and three females were seen perching on different branches of a Ficus tree. All were calling simultaneously. One pair (♂ ♀) was more active than the others. The female, which perched on the lower portion of a horizontal branch assumed begging posture towards the male perched a little higher next to her on the same branch. The male though silent now, occasionally a gave 'krawk' call and 'touched' the female's bill and hopped away. Twice the male brought out a berry and offered it to the female. This went on for sometime as both kept hopping from branch to branch and finally flew away together. Several pairs (♂ ♀) were seen together in the different parts of the island. This suggests that courtship was still in progress.

Relations with other animals :

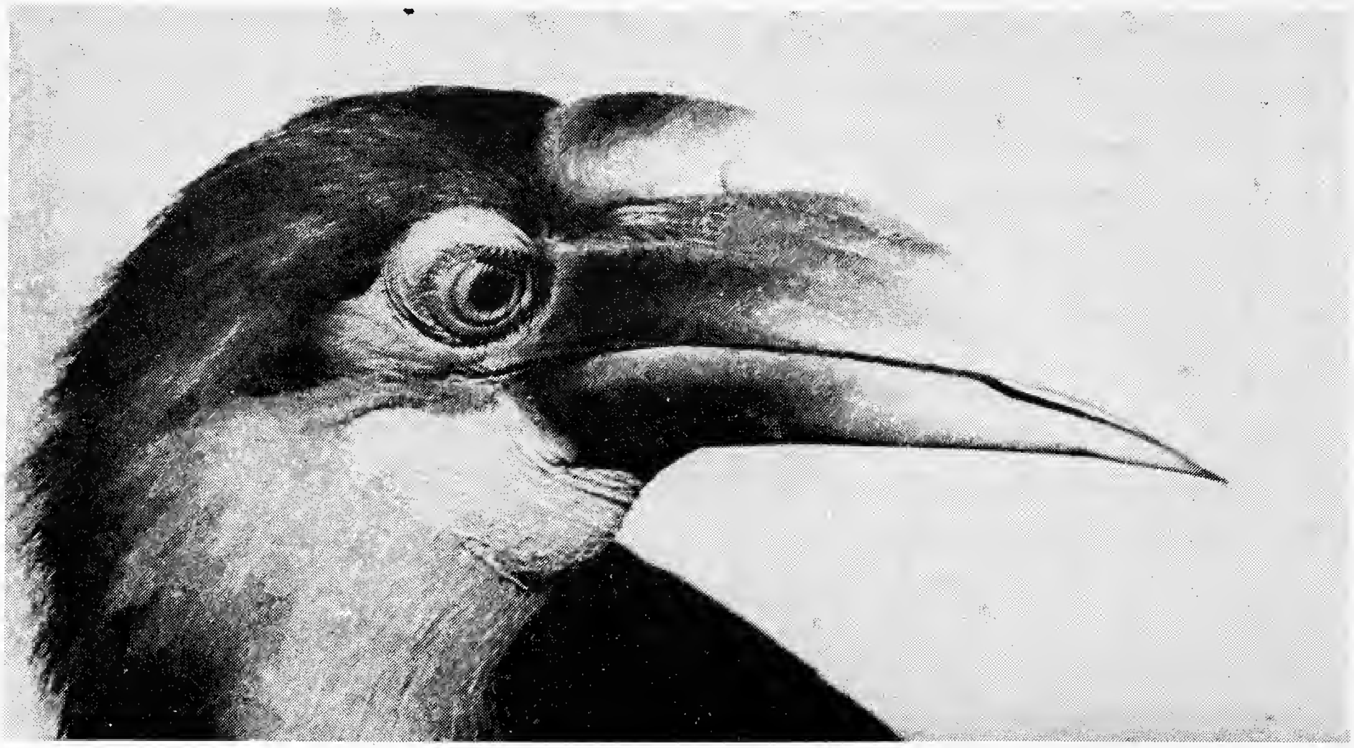
No predators have been recorded so far but rats and water monitors are the only large animals/reptiles in the islands. Flying snakes (*Chrysopelia paradisi*) are very common and on one occasion one was observed passing on branches very close to a hornbill's nest containing a female and young. Once several hornbills were seen mobbing a whitebellied Sea Eagle (*Haliaeetus leucogaster*) from tree to tree. Abdulali (op. cit.) also mentions similar occurrence earlier. A koel (*Eudynamys scolopacea*) was also seen being chased by a hornbill. Human presence in the island is a recent phenomenon and though the impact of their presence throughout the year could not be assessed it may be assumed that the nesting pattern of the hornbill, may be affected as they would avoid nesting on lower available sites due to disturbance/predation by man.

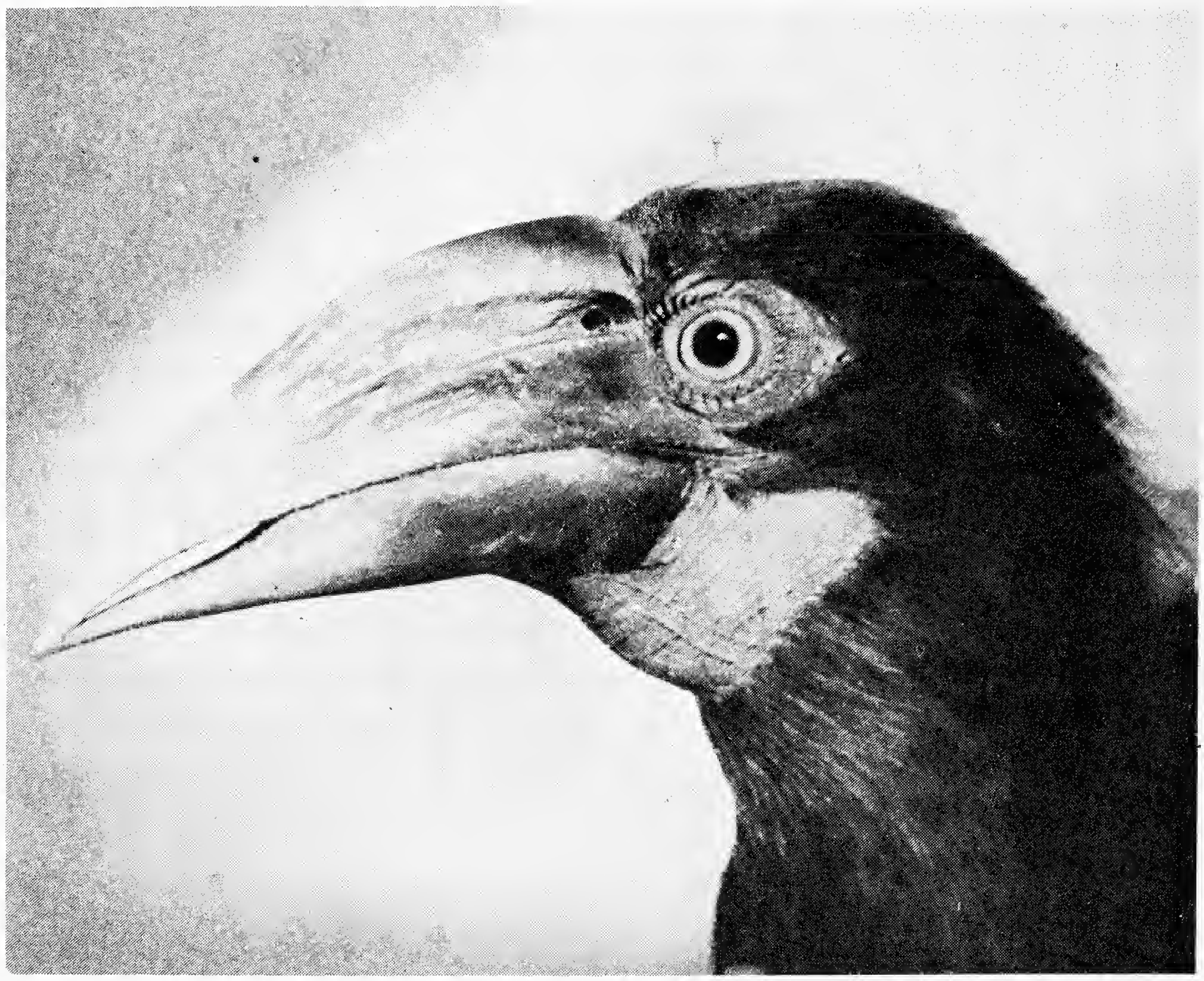
Development of the young :

The egg (only one obtained) was earthy brown in colour. This may be due to staining. It measured 33 × 45 mm and weighed 28 g. The same nest contained a chick about a week old. It weighted 75 g and measured 130 mm from tip of the beak to vent (Plate II). The



On 26/4/1972 'A' on right, 'B' on left.
(*Photo*: Courtesy Indian Express, Madras)





Above: 'A' ♂ on 13/11/1972 *c* 9 month old.
Below: 'B' ♀ on 13/11/1972 *c* 9 month old.
(*Photos*: S. A. Hussain)

body completely naked except about 10 rudimentary rectal barbs in an arc immediately above and between the anus and the oil gland. Similar barbs, numbering about 23 along the basal half of the wing along the alar tract. The upper mandible from gape to tip was *c* 25 mm, and the lower *c* 27 mm. The depth of the bill *c* 13.5 mm and the tarsus measured *c* 16 mm, the eyes were completely closed. Both the egg and the chick were preserved.

The exact age of the two other chicks obtained could not be ascertained though it is assumed that the interval of hatching between the two was about 10 days, but this factor needs further investigation. The present observations on the growth were made from the date (13 April) the birds were removed from the next.

Of the two, one was considerably larger and ultimately turned out to be male. It was not possible to ascertain the sexes of them at this stage as both seemed to have similar plumage i.e. rufous on head and neck. The chicks were named 'A' and 'B' for the sake of convenience of description through various stages of development. (It became apparent in the final stages of growth that smaller 'B' though it started of with the rufous plumage of a male, acquired black plumage of the ♀ after the post-juvenile general moult and thereafter became a full-fledged female). Descriptions of development recorded for the period April 1972 — March 1973 etc are given below. Body measurement and weights are given separately (see Figs. 4 and 5). The actual dates of measurements vary, though taken roughly during the middle of each month. There are some obvious gaps in data as I was away on other assignments during that period.

Both the parents and chicks, kept in a makeshift cage were brought to Port Blair and then on to Madras by ship and then to Bombay by passenger train. The parent male died on board ship one week after capture. He had refused to eat. The female accepted food occasionally but did not feed the young which were kept in the cage along with her. The young however, fed voraciously. The female escaped from the cage when an enthusiastic reporter from a daily newspaper in Madras tried to photograph it in my absence. Though the newspaper sent out an appeal through its columns for information, she was never found and was believed to have died somewhere in the city of Madras. The chicks were brought to Bombay and were temporarily kept at Hornbill House. A cage measuring *c* 12′ x 20′ x 8′ was subsequently built in the compound adjacent to Hornbill House and the pair remained there till their death 6 years later.

Development :

13*th April* 1972 : 'A' — Rufous feathers on crown. Auriculars in sheath. Lores, area below the eye, nasal groove, hind-neck chin, throat and upper breast naked. The colour of skin in these areas smalt blue and rest of the area pinkish yellow. Vent, lower abdomen patchily feathered. All feathers in sheath. Upper tail coverts and lower back with a few barbs. Wing coverts well developed. A few feathers on the tarsus — oil gland swollen, and a line of feathers encircling it. Stomach greatly distended. Wing and tail in moult. Bill waxy yellow. Gular pouch pale blue. Eyelashes well developed. Irides pale blue. Soles of feet pale blue. Wing 153 mm, Bill 72 mm, tarsus 47 mm, tail 96 mm.

'B' — A few barbs appearing on the crown, nasal groove; whole back, breast, abdomen naked. Wing coverts fully grown. A few tufts of feathers around oil gland. Bill 58, tarsus 41 tail 58, weight 380 gm.

Behaviour : Call monotonous and conti-

nuous chew, chew, chew . . . Both ignored their parents and vice versa, though kept in the same enclosure. Defecation was carried out by stretching the neck out, raising the wings, projecting the anal region and stepping backwards towards the edge of the enclosure. When on an open ground, the 'stepping back' is continued till the faeces is discharged. Picking up and throwing about whatever object found nearby. Pecking at the toes of the observer (resemblance to seeds?). Both voracious eaters, were fed on creamcracker biscuits, bananas, and other fruit.

May 1972 : 'A' — A line of rufous feathers in pin immediately below the gular pouch. Auriculars fully developed. Feathers on vent and abdomen fully developed. Upper back and lower hind neck patchily feathered. Base of the upper mandible swollen, showing a faint trace of wreath (furrow). Bill waxy yellow except at the base where it is reddish.

'B' — Crown, ear coverts, upper and lower tail coverts fully developed. The feathers adjoining these areas in pin.

September 1972 : 'A' — All body feathers fully grown. Crown and nape dark rufous. Throat sulphur-yellow, grading into rufous towards the upper breast where it meets the black of the abdomen. The feathers of abdomen and tarsus softer than those on the back, wing coverts and scapulars. Gular pouch light blue. Bare skin around the eye smalt blue. Bill waxy yellow, the basal tinge of red increased in tone. A gap of about 2 mm between the mandibles about 8mm from the tip.

'B' — All body feathers fully grown. Feathers adjacent to the gular skin appear blackish. Lower neck where the black of abdomen merging with the rufous of the neck seems to extend upwards. A few feathers on the crown have a barred appearance. The rufous feathers on the head and neck dark greyish on the basal half.

November 1972 : 'A' — Swollen casque of the wreath broad at forehead tapering towards the tip, about 72 mm in length. Depth of the bill including the wreath 50 mm.

'B' — Feathers on the crown (Centre streak) turning darker. A line immediately below and along the gular pouch black. Another streak across the ear coverts extending down to hind neck blackish. Swollen casque 50 mm. Depth of the bill including the casque 42 mm, gap between the mandibles about 2 mm.

December 1972 : 'A' — Depth of the bill 72 mm. Tip of the swollen casque blunted due to wear.

'B' — Black feathers in sheath in a line above the eye (almost a central streak). Similar streaks below the eye and extending upwards from the black feathers in the abdomen and breast. Another line of black feathers extending upwards from the upper back towards the crown. Rest of the neck area dark brown, depth of bill 43 mm, wreath 50 mm.

March 1973 : 'A' — Depth of bill 54 mm, 2 central tail feathers and 7th primary moulting. No body moult.

'B' — Extensive dropping of body and flight feathers. Heavy body moult. All the feathers moulting in the head and neck area black.

From March 1973, onwards the plumage of 'B' showed a marked overall tendency to become black. By the end of May the moulting was over. The moulting of the wing and tail feathers was irregular. Both the birds shed their flight feathers irregularly, sometimes even freshly moulted ones. Powdered calcium sandoz was added to the regular diet during this period. By this time 'B' attained the full adult female plumage.

In August 1973 the transverse band on the wreath turned opaque and developed a soft

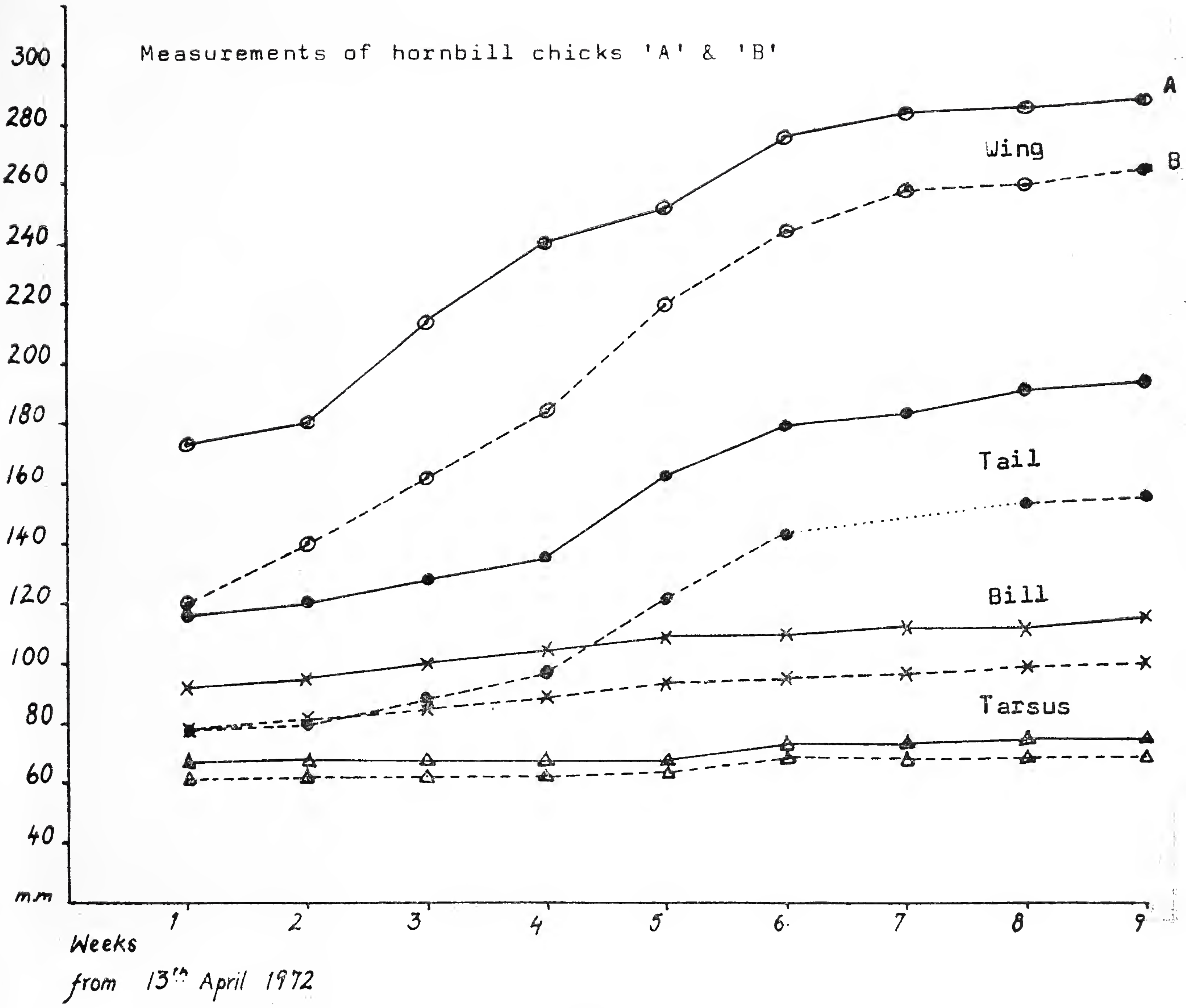


Fig. 4.

wrinkled depression where small blood capillaries were seen.

Soft parts : Colour of the irides remained pale grey in both ♂ and ♀ throughout while the eye lids of ♂ turned red in colour. Bare skin around the eye and the gular pouch blue.

Measurements of wing, bill, tarsus, and tail were noted at intervals (Fig. 4). Weights were also noted for the same period (Fig. 5). The measurements of wing and tail were discontinued after March 1973, as their tips were either breaking or wearing out as the birds constantly flew around in the cage.

Food and behaviour in captivity :

Both were fed on suttoo (powdered roasted Bengal gram) mixed with glucose powder and a few drops of ABDEC, supplemented with fruits like bananas, apple, guava, jamun (*Syzigium jambolana*) marshmelon, mango and sapota, hardboiled eggs and chopped meat was given in the initial stages.

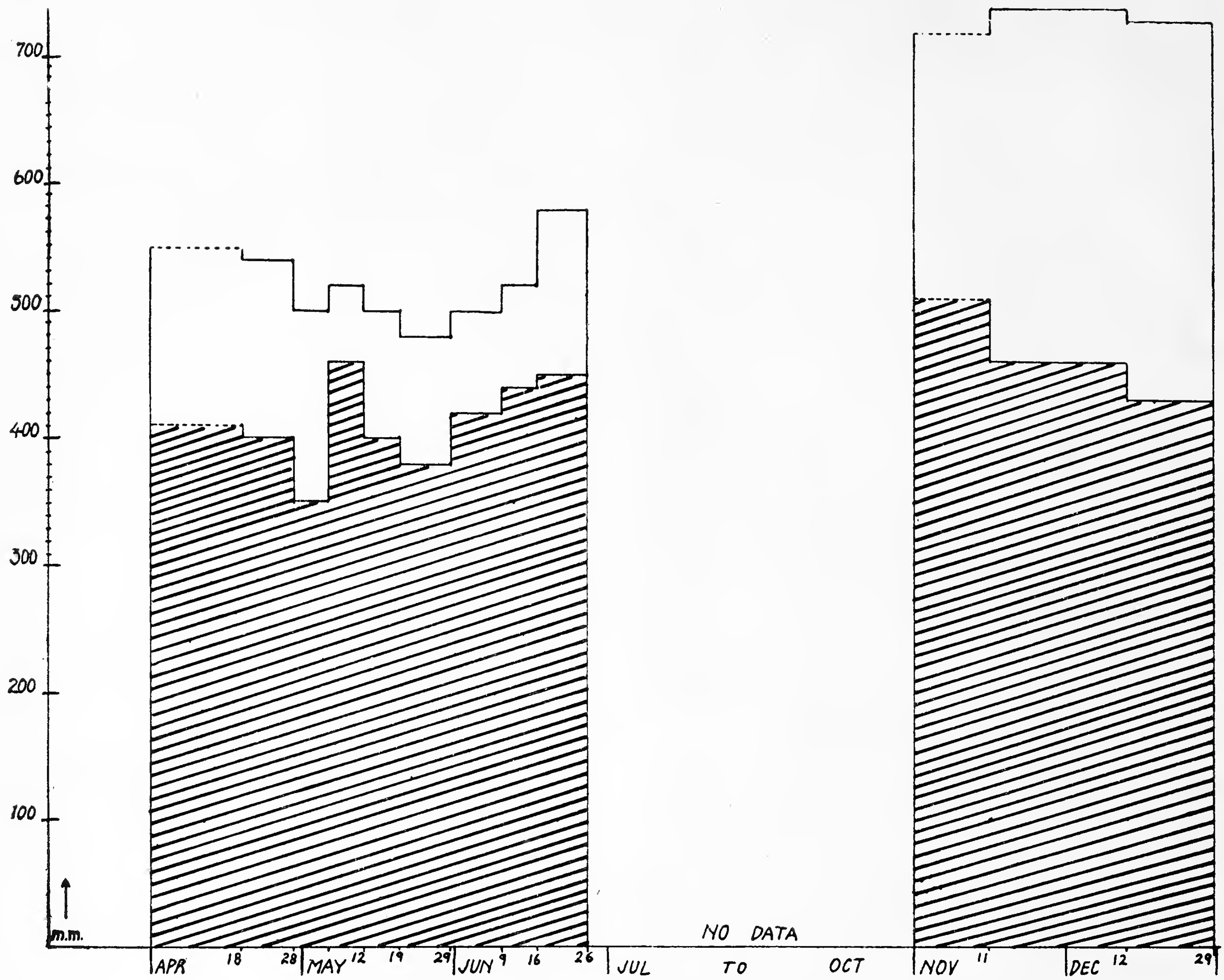


Fig. 5. Weights of chicks (blank area — male, shaded area — female)
In *Tockus* hornbills nestling weight reaches a peak at the completion of body growth indicated by tarsus and ulna measurements. Thereafter weight declines erratically untill about fledging time and once again rises to a constant level (Kemp 1976). Figs. 4 & 5 indicate here that the body growth had reached a peak around the beginning of April and Fig. 5 indicates possible fledging period around mid-May.

Sporadic jerky movements of the head, a trait also observed in adults in the wild state. Occasionally tossing up the head and rubbing the crown on upper back. An occasional fruit or a morsel of food would be brought up and swallowed again. Hard seeds are regurgitated, preening is done throughout the day at irregular intervals. Head is scratched by extending the wing, and bring up the leg over it, (indirect scratching).

'A' (♂) was aggressive towards 'B' (♀) and would not allow it to come near, often attacking and chasing it around the cage.

There was no significant change in plumage

Above: Male about 4 years old.
Below: Male & female before the 'fight'.
(*Photos*: S. A. Hussain)

or body size/weight in the following years, but in February 1977 the iris of male appeared to change colour from grey to reddish. At the same time the female began to show interest in a nest box (prepared from a sawn-off tree trunk) placed inside the cage. The male however did not show any sign of breeding condition. The female became more aggressive and finally both had to be separated by a partition inside the cage. It was possible that the female was imprinted on humans and regarded the male as a threat to pair bond (A. C. Kemp, per. comm.). The female continued to be aggressive towards the male even after the normal breeding season (March-May) was over and finally on 8th March 1978 she managed to sneak across the partition and attacked the male gripping his throat in her beak till she was separated with considerable effort. The male died the following day. The female was later sent to the Zoological Park at New Delhi where she died within two months of arrival.

Discussion

The very limited scope of the study carried out in Narcondam island restricts any detailed discussion. One of the factors that restricted a more detailed and systematic enquiry was that the expedition was mainly aimed at collecting biological specimens and as such most of the time was spent in that direction. However, it was possible to document, both in the wild as well as in captivity, some hitherto unknown aspects of the biology and ecology of the Narcondam Hornbill.

Ecological status :

Random estimates made by the earlier visitors to the island, i.e. *c* 200 birds is much less than what I believe to be the actual population. Daily counts were made by me during my 'collecting' forays (not more than 2 km in various directions in the island) and the birds seen in flight as well as on trees were recorded. The highest counted in one day was 72 males and 28 females (see table 2). These numbers include a point count made on a feeding tree where the hornbills were mobbing a white bellied sea eagle. My one month long stay in the island gave me the impression that there are more than 200 birds in the island. All the earlier visitors landed there in the months of March-April which happens to be the breeding period when most of the females would have been confined to nest-holes. However the figures mentioned in the above table cannot be interpreted statistically to project the probable population size since the factors contributing to the regulation of population in the island are not known. What, then, is the optimum population and what is the factor that regulates it?

The apparent (?) absence of large predators in the island (including until recently, man) abundance of food resources with perhaps some degree of competition for resource from other frugivores in the island such as Green Imperial Pigeon (*Ducula aenea*), Pied Imperial Pigeon (*D. bicolor*) and the Giant Fruit Bat, provides an ideal ecological niche for a successful survival of a species like the hornbill. This is borne out by the fact that the Narcondam hornbills raise two chicks while most other larger species of *Rhyticeros* are able to raise only one chick (Kemp 1979). Competition for nesting sites during the breeding season may restrict the actual breeding success as the hornbills do not excavate nest holes. The severe cyclonic storms that lash these islands destroy a great number of older nesting trees, even causing mortality of brooding females/chicks confined in nest-holes. The competition for nesting sites may actually be acute

in the island as evidenced by the fact that two of the nests studied were as low as 2.5 to 2.7 m from the ground. Another possible regulating factor may be perhaps the very insular nature of the species where in-breeding is discouraged among siblings. The female chick's assuming male plumage upto fledging period may actually be a mechanism evolved for this purpose. Was the antagonistic behaviour of the male towards the female initially and then the female towards the male once she attained breeding condition in captivity a part of the behaviour pattern evolved in the wild state to discourage mating among siblings? All this, is of course hypothetical and needs to be studied.

Conservation outlook

Island ecosystems are, in a way, living laboratories for the study of evolution. The very simplified nature of the isolated islands provide us with an insight into the complexity of nature at work. Some of the factors that contribute to such systems are competition, predation, physical environment and their effect on the insular nature of small populations inhabiting these (Diamond 1982). If any one of these factors is jeopardised there is a danger of such populations becoming vulnerable to extinction. It has been demonstrated repeatedly elsewhere that the single most important cause for species extinction on oceanic islands has been predation by alien elements including man.

The vulnerability of the endemic birds is emphasised by the fact that most of the birds listed in the IUCN's Red Data Book occur in islands. It is estimated that in the past 400 years two hundred of the estimated 220-odd species and subspecies of birds which have become extinct have been island forms. Most of these became extinct either because of the loss of habitat or when the population size was too small to compete with alien competitors and predators, or even some catastrophy such as disease.

Where does the Narcondam hornbill stand under the present ecological conditions? It is definitely not facing the danger of extinction as yet but it is vulnerable and some conservation strategy has to be evolved to protect the species from possible future exposure to the factors mentioned above. Even if one were to make a liberal estimate of the total population of the hornbills to be about 400 it will be perhaps too small a number to cope with ecological disasters like an outbreak of an epidemic or an extensive destruction of habitat. What, then could be the strategy to ensure the safety of this unique species?

First of all a complete ecological study of the hornbill is necessary to understand its status. Conservation measures based on such a study will be one of the answers to the question. Captive breeding, which has been successfully carried out with several endangered bird and animal species elsewhere, is a tempting prospect. However, it may not be necessary in the case of Narcondam hornbill. On the contrary, it would be much better to find out other islands within the Andaman group having similar ecological structure and introduce the birds there. There are about 300 islands in the Andaman group of which about 60% are uninhabited. In the north Andaman group, which are close to Narcondam, there are several off-lying islands like Landfall, East, Interview and Barren having close affinities with the ecological conditions in Narcondam. A third alternative is to provide suitable artificial nesting sites in the island itself.

In conclusion it may be suggested that once the need to conserve the species against possible extinction is sufficiently acknowledged, the following strategy may be instituted :

1. Studying the complete ecology of the Narcondam Hornbill.
2. Emphasis on study of ecological requirement, food niche, and the nesting success in the island.
3. Study of the habitat, vegetation structure and faunistic composition in the island.
4. A comparative assessment of habitats of nearby islands.
5. Experimental capture and transfer of a few pairs of hornbills to alternate sites under careful supervision.
6. Monitoring the progress of introduced populations in their new habitats.
7. Declaring Narcondam and the island/s selected for transfer of the species as completely protected.

Acknowledgements

Under the direction of Mr. Humayun Abdulali, who first initiated the series of collecting expeditions to the Andaman and Nicobar islands, Robert B. Grubh and R. J. Pimento of BNHS spent a few days on Narcondam. They collected several specimens of the hornbill and attempted a rough count of its population. In 1971 Mr. Humayun Abdulali himself paid a fleeting visit to Narcondam and took a few more specimens. Since then, following a spurious territorial claim by Burma, a police picket of 16 men has been posted on the island posing a potential threat to the bird. Therefore, I am particularly grateful to Mr. Abdulali for the opportunity he provided me for this trip to Narcondam under the Charles McCann Vertebrate Zoology Fund for a field study of this unique species while it is still relatively safe and plentiful. I am also grateful to Mr. Harmender Singh, the then Chief Commissioner, and Mr. S. Vajpayee, Chief Secretary of Andaman Administration; Mr. V. N. Singh IPS the then Superintendent of Police, Mr. Fred Burns, Manager, WIMCO (since deceased); Mr. Bhaktawar Singh, Dy SP; the Master and crew of Police boat M. V. Jawahar (who cheerfully dropped us at Narcondam) the Radio Officer and the Police party, including the cheerful Nicobarese policemen for their assistance in various ways, Mr. N. J. George, of Prince of Wales Museum was of great help in collecting specimens and Mr. Pat Louis, who arrived with his cameras, provided a photographic cover to the trip.

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SEASONAL VARIATION IN THE POPULATION OF *ACRIDA EXALTATA* WALK. AT ALIGARH[1]

SHAMSHAD ALI[2]

(*With seven text-figures*)

The population level of *Acrida exaltata* over three years (1974-76) at Aligarh has been discussed. Information is furnished on seasonal variation, intra and inter year fluctuation and life cycle in natural conditions. Climatic conditions exert marked influence on the rise and fall of population. The timing of the various life history events (i.e. oviposition, hatching and maturation) varies widely from year to year depending upon the particular sequence of climatic conditions prevailing throughout the entire grasshopper cycle.

INTRODUCTION

Acrida exaltata Walk. is a serious pest of cotton and tobacco. Besides cotton and tobacco, it also attacks rice, sugarcane, potato and grasses. It has long been recognized that the wide fluctuations periodically occurring in acridid populations throughout the world are closely linked to weather conditions (Parker 1935, Dempster 1963). The major weather factors involved are apparently temperature and precipitation. In some characteristically very dry regions, rainfall may be the principal limiting factor in grasshoppers distribution through its influence on food (Scharff 1954), breeding behaviour (Uvarov 1956). Putnam (1954) said that grasshoppers outbreak usually coincide with extended period of hot, dry weather. Descamps (1975) studied factors influencing the distribution and abundance of acridid population in general.

Studies were made to note the seasonal variation in the population of *Acrida exaltata* Walk., due to various environmental factors at Aligarh.

MATERIAL AND METHOD

The field observations were undertaken for three years from January, 1974 to December, 1976, during different months of the year. The samples of hoppers and adults were obtained by sweeping. A standard net was used for collection. The insects were collected in the morning on every tenth day for an hour from the acridid field station (Scindia Fort, Aligarh). Meteorological records were obtained from the weather station, Department of Physics, Aligarh Muslim University, Aligarh. Data on peak density recorded each month in the area for the period (1974-76) were used for analysis. These monthly peaks were then analysed for the three months, each constituting four seasons, Winter (December to February), Spring (March to May), Summer (June to August) and Autumn (September to November). Only the mean values of various seasons were considered to reveal intra and inter year fluctuations. The reason for using

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seasonal instead of monthly population was to obtain 'nil' population values, invariably encountered for months at a time, specially during Winter and Spring seasons.

Inter year fluctuation was measured by the deviations of the seasonal mean from that of annual mean for three years. Comparative behaviour of two types of fluctuations was also studied.

Studies were made on the life history of *Acrida exaltata* Walk. under natural conditions.

Observations

Topography: The geographical position of Aligarh is 27° 53′ 38″N. Latitude and 78° 04′ 30″E. Longitude. The district of Aligarh lies in the upper Doab of the Ganga and Jamuna rivers.

Climate: Aligarh experiences tropical monsoon type of climate. The year is generally divided into the following three seasons —

1. The cold weather: Winter (Late October to February),
2. The hot weather season: Summer (March-June),
3. The season of general rains: (Mid-June-September).

During winter the temperature is generally low. The mean maximum temperature is 80°F, however, the mean minimum temperature remains around 50°F. The prevailing direction of wind during the season is from West and North-West to South and South-East. The winds are generally light with an average speed of 2 miles/hour. These winds are supposed to be of continental origin and are mostly dry. The month of December and January are the coldest and often register light rains due to western disturbance otherwise the weather is generally fine and pleasant due to bright and sunny days with clear sky. The month of May and June are the hottest with mercury shooting sometimes upto 115°F, however, the mean maximum temperature is 115°F and the mean minimum temperature 65°F. Strong dust raising hot and dry westerly winds during day time is common feature of the summer. The peculiar phenomenon of the summer is the frequent occurrence of dust and thunder storms with an average velocity of 30-40 miles/hour gales. The humidity sometimes falls to 2 or 3% whereas the general level is 20%.

With the onset of monsoon generally by late June, the direction of winds is reversed due to low pressure area developed in the north western India. With the arrival of the humid oceanic currents from the Arabian Sea as well as from the Bay of Bengal, the tempera-

Table 1

Average monthly rainfall at Aligarh (1974-76)

(in mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December
1974	0.0	0.0	0.0	0.6	20.9	31.8	230.9	193.4	5.5	19.6	0.0	17.2
1975	19.4	10.0	0.7	0.0	23.7	74.1	247.9	146.4	312.6	68.1	0.0	0.0
1976	0.0	13.0	5.0	11.8	22.6	35.7	354.4	426.4	73.9	0.0	0.0	0.0

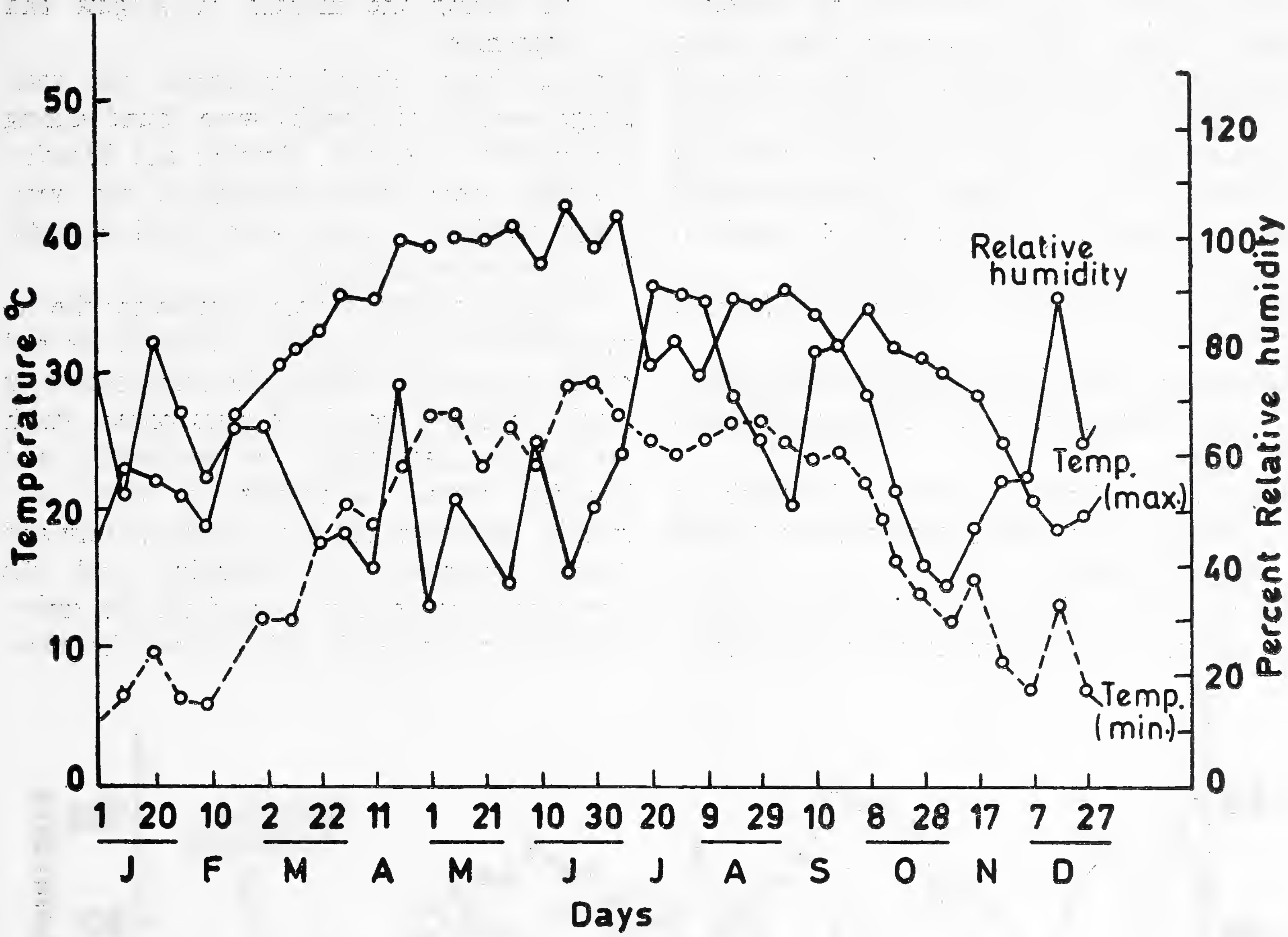

FIG. 1 CLIMATIC DATA 1974

ture falls and the air becomes cool. The mean monthly temperature falls to 80°F in July. The relative humidity increases to 70-74% R.H. The sky is generally overcast in the rainy season. This season receives nearly 90% precipitation of the whole year and the mean seasonal ranfall is 25″ (Table 1 and Figs. 1, 2 and 3).

Vegetation: Water penetration plays an important part in determining the distribution of vegetation. Scindia Fort is rich in green vegetation. Abundance of food is available for feeding by grasshoppers, and is surrounded by cultivated crop fields.

It was found that hoppers and adults were most abundant during and after the monsoon period (July-October) due to the optimum ecological conditions, particularly temperature, relative humidity and food for their development and biological activities. As is evident from Figs. 4, 5 and 6 the population was lowest in winter (December-March) and summer (May-June). This is due to slow reproductive activities during this period. Copulation was observed to be higher in July to October, Oviposition was also higher.

Egg pods laid during April to June, hatched after the monsoon showers in July since suffi-

cient moisture was available for the development of eggs. But during the heavy rains, hatching of eggs decreased, but again increased in August to October. The population of hoppers and adults was at its maximum from July to October, but decreased in subsequent months due to the advent of winter (Figs. 4, 5 and 6). This decrease continued till February.

Seasonal Life History at Aligarh under Natural Conditions:

Copulation: From 15th March to 31st October. Maximum in July, August and September.

Oviposition: From last week of March to middle of November. Maximum in August and September.

Hatching: From first week of March to December last maximum hatching was observed during the months of August and September.

Hopper Stage: Found throughout the year. Large number of nymphs were found during the months of August, October and March.

Adults were found throughout the year. Large number of adults were found in October, November and April.

Climatic conditions were suitable for the reproduction only for a short period at the end of the dry season. During the rainy season, it results in rapid growth of grass cover, which favours the grasshopper; the temperature and humidity remain favourable for about two months. However, the heavy rains in July and August increased soil humidity and the Oothecae were destroyed and from November temperature frequently falls below the thre-

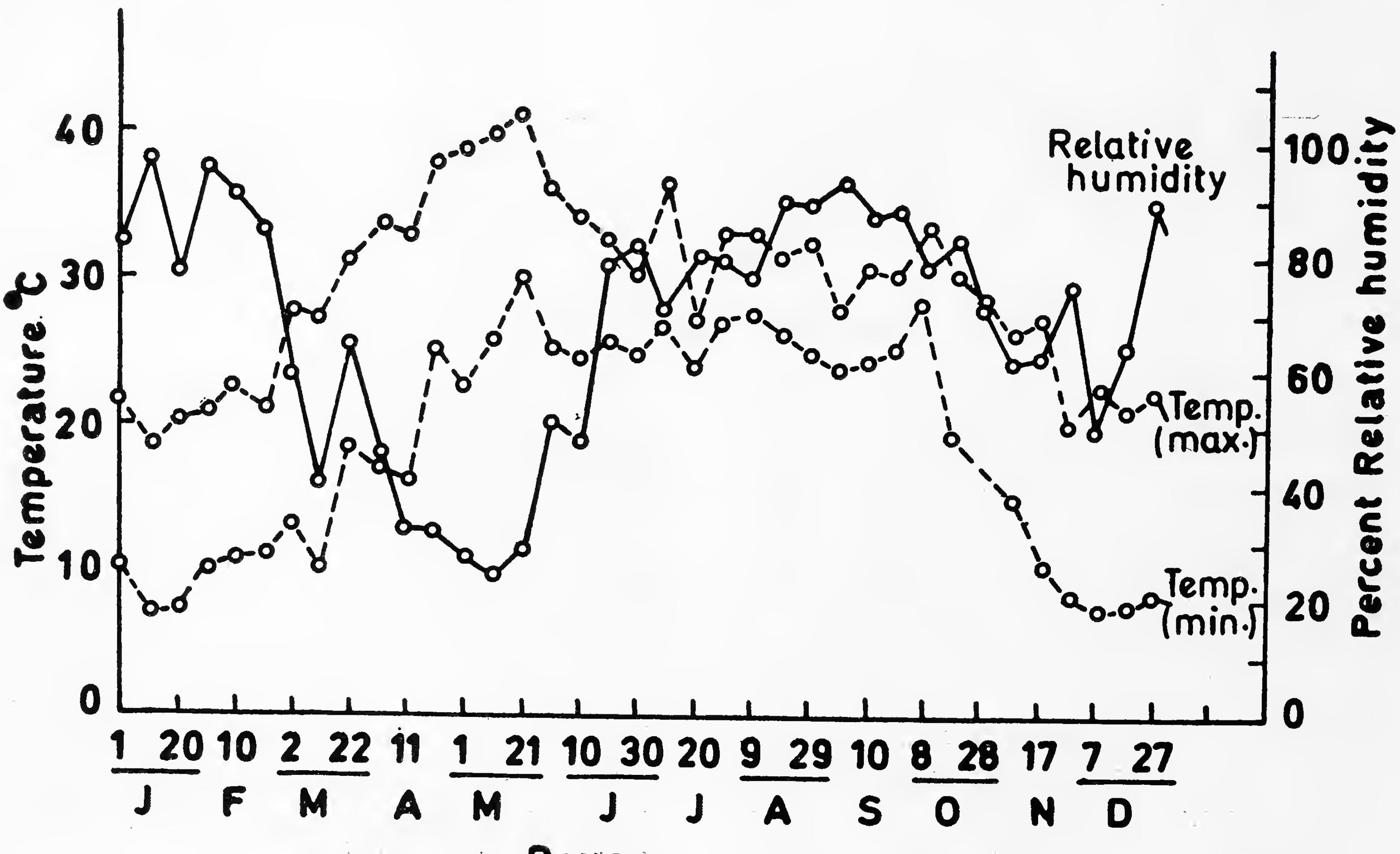

FIG. 2 CLIMATIC DATA 1975

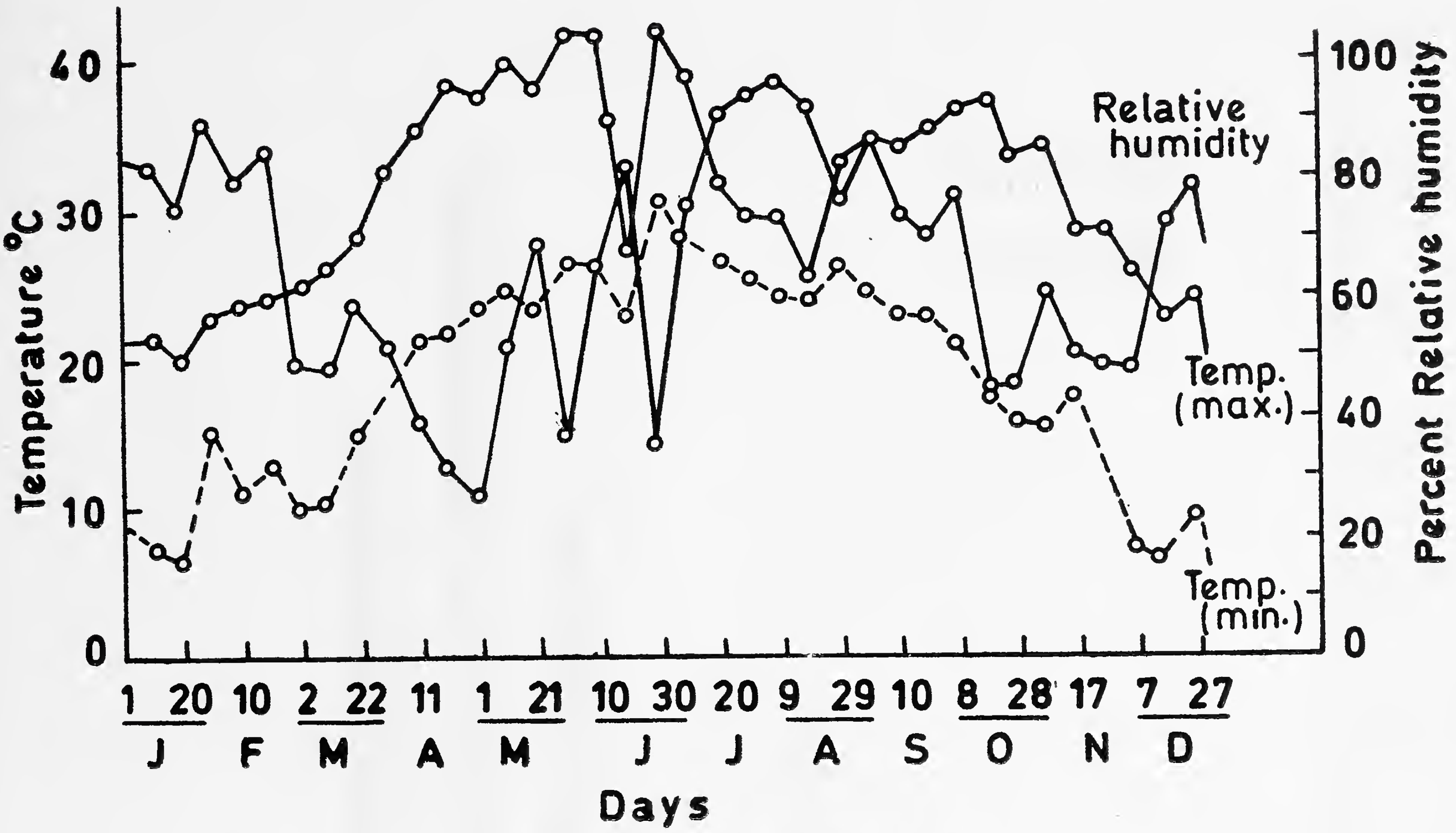

FIG. 3 CLIMATIC DATA 1976

shold for development. During the dry season, low temperatures induce degeneration of the oocytes, disrupt spermatogenesis and change the sex ratio in adult populations. It was found that the populations in the area was maintained only by migration from other localities.

Inter and Intra Year Fluctuations:

Apparent intra year fluctuation of the mean peak density populations in respect of the Winter, Spring, Summer and Autumn seasons are shown for three years from 1974-76 in Fig. 7. The highest peak usually occurs during the Autumn season with the characteristic sharp fall in the next winter. However, for the years 1975-76 Summer peaks were maximum.

Discussion

In the present three year study, the relationship between egg production and temperature was particularly apparent during the month of September which showed extremely variable climatological conditions from year to year. September is a transitional period between Summer and Winter, when rapid change in temperature again occur. In order, grasshoppers may take advantage of the optimum egglaying periods during mid Summer and so attain their maximum reproductive potential, it is essential that they mature early in the season. Early maturation is dependent upon a continued sequence of high temperatures through all stages of development extending even back to the previous fall following deposition of eggs. Continued high temperatures permit rapid development of nymphs to the adult stage followed by advanced maturity, early mating and oviposition. On the other hand, a complete reversal of the weather patterns just outlined, with consistently low

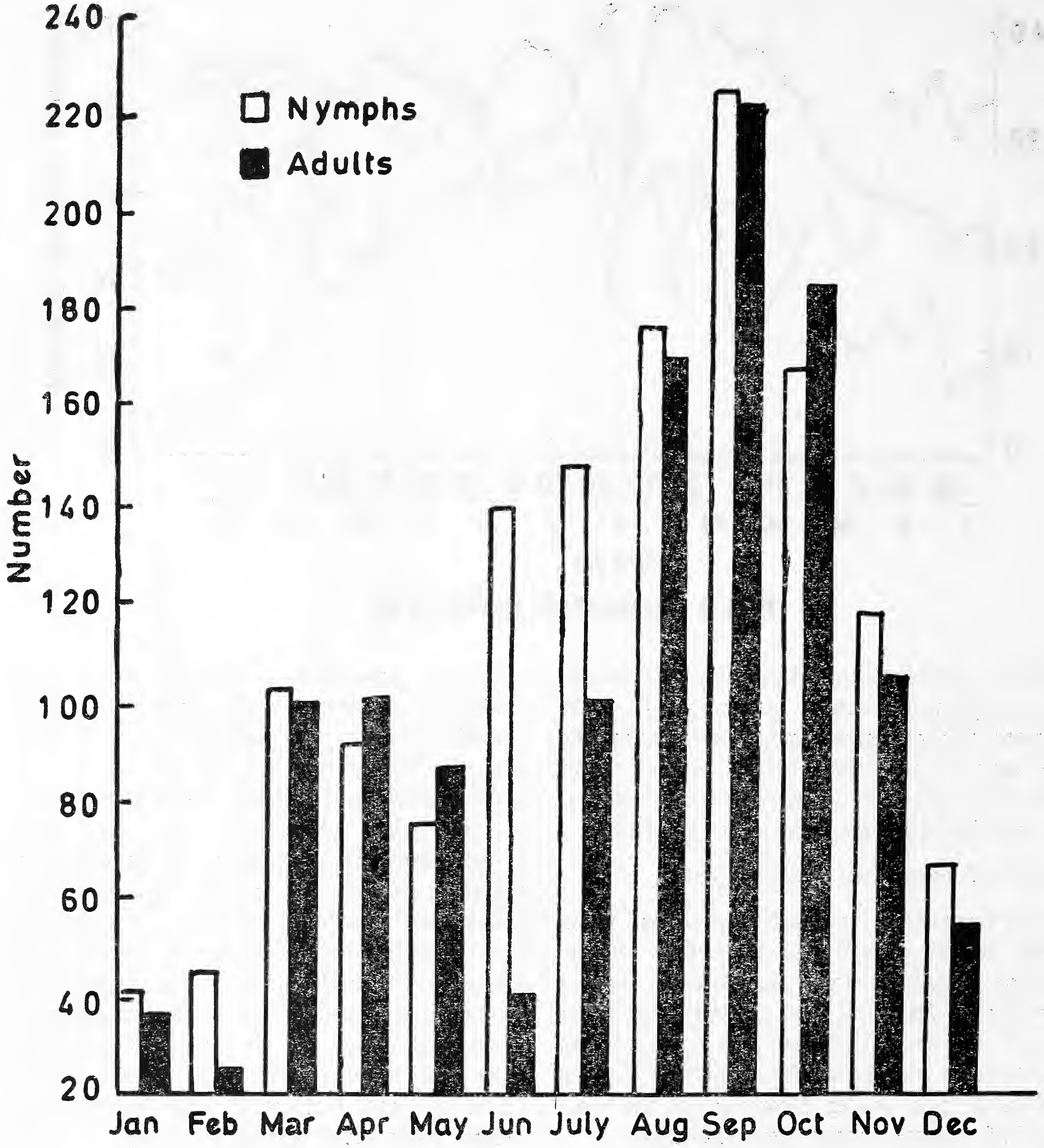

FIG. 4 MONTHLY POPULATION—1974

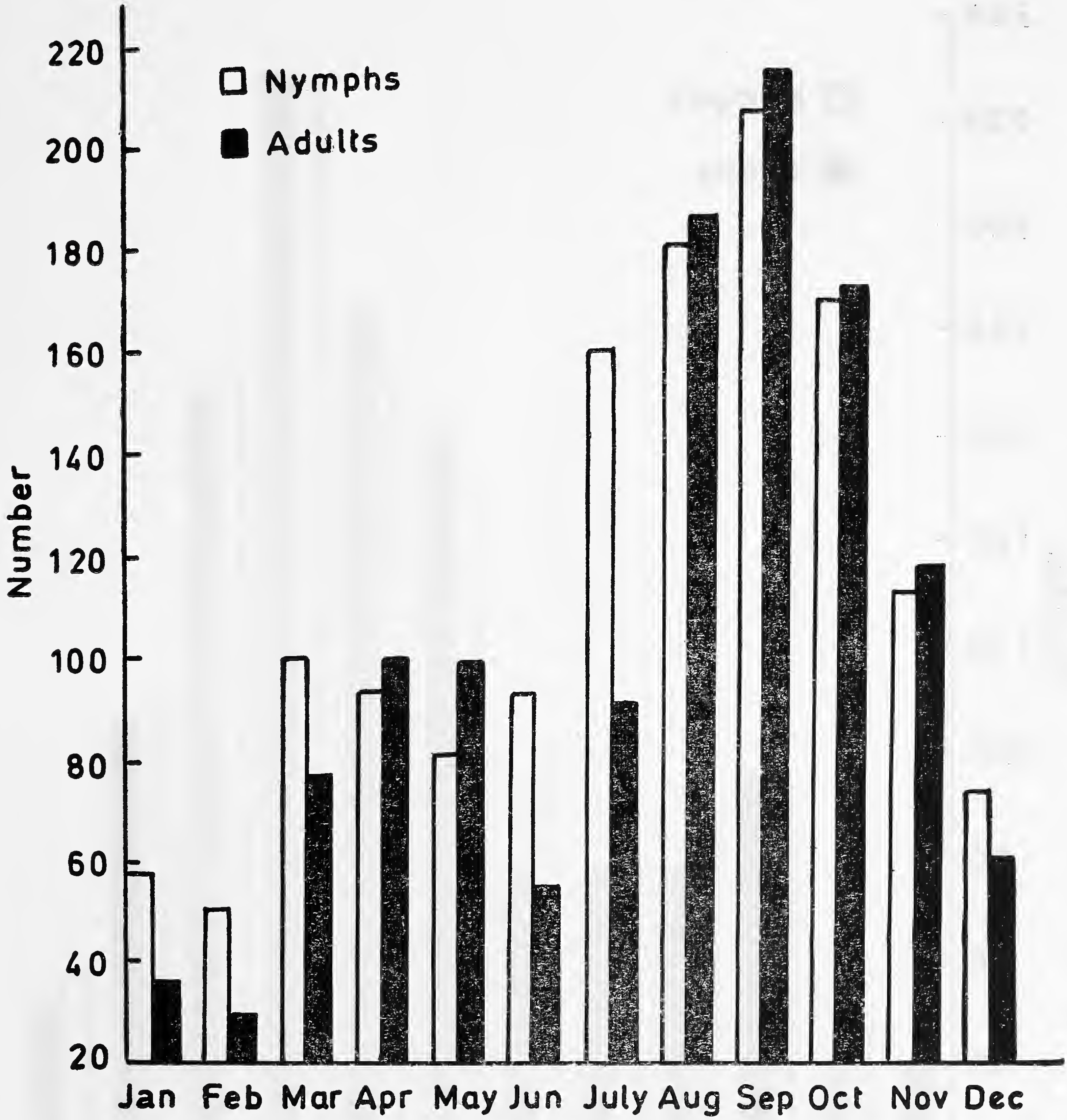

FIG. 5 MONTHLY POPULATION—1975

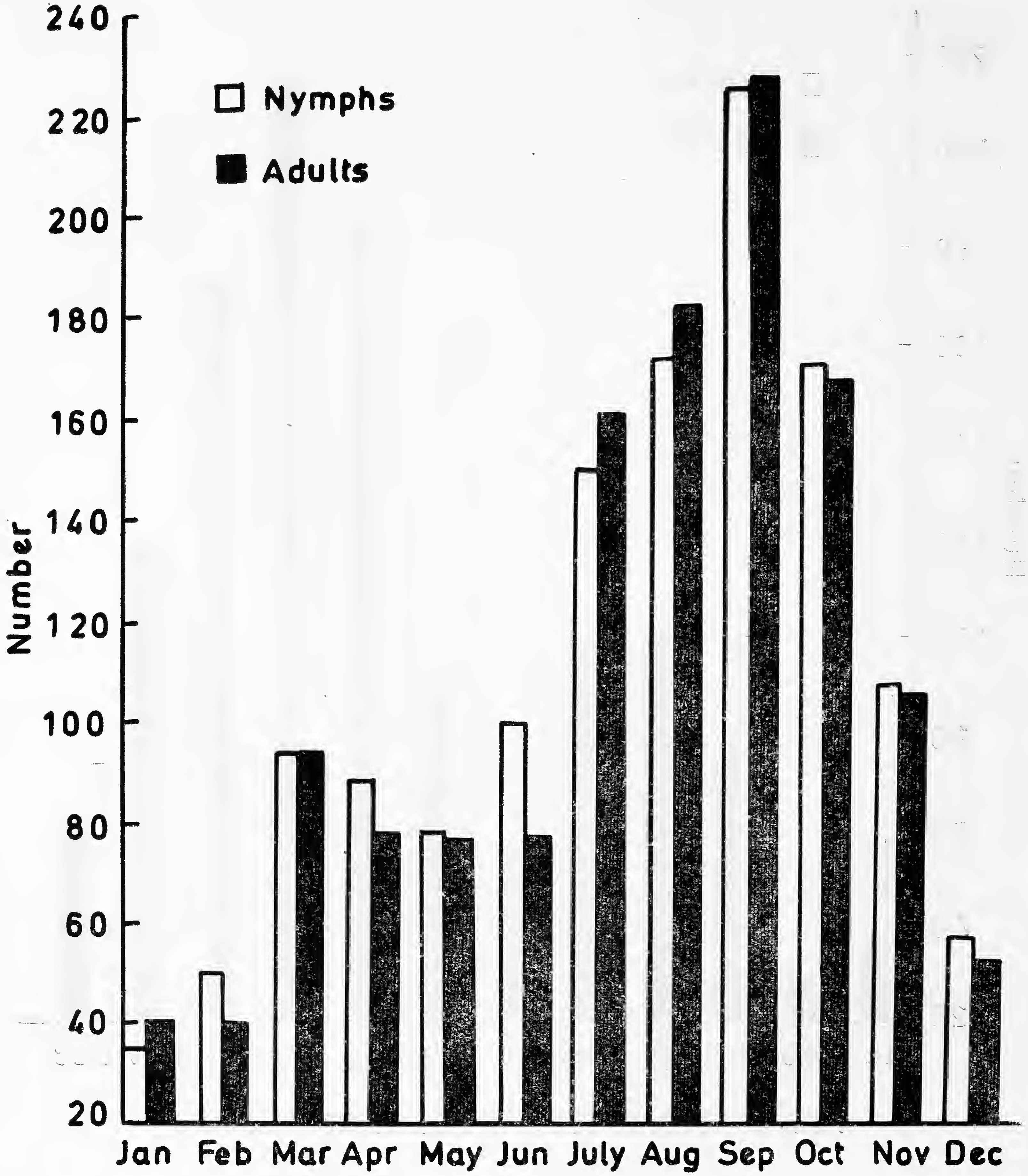

FIG. 6 MONTHLY POPULATION—1976

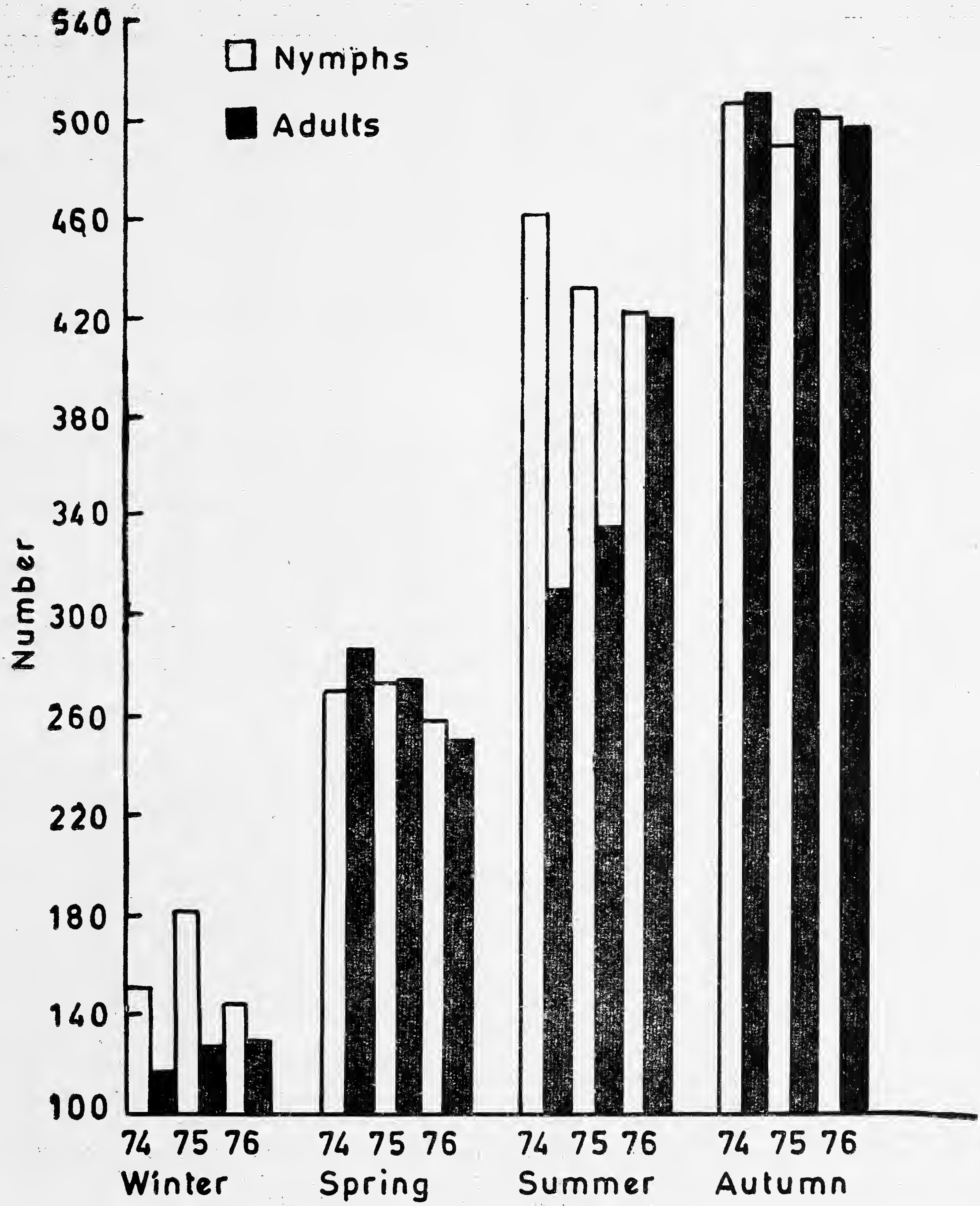

FIG. 7 SEASONAL POPULATION (1974—76)

temperatures through the various stages of growth and development will result in drastic reduction of the number of eggpods laid. In eggs laid after mid September the percentage of hatching was drastically reduced, these eggs while still apparently viable showed only minor embryonic development.

Similar observations were made by Suslik (1975), who observed that seasonal dispersal of grasshopper was found to depend on the height of the grass stand, and population density varied at different times of the year. Pickford (1970) gave the reason for population increase as due to favourable environmental conditions, which resulted in increased fecundity and survival of more eggs Randell and Mukherji (1974) observed that increase in population was due to high temperatures at the time of egglaying.

Temperature during peak population density was highly significant (Edwards 1960). Increase in population due to high temperature at the time of egglaying was also supported by Randell and Mukherji (1974). Heavy rain in an outbreak area gave rise to increase in population (Cassimir 1962). Descamps (1975) studied factors influencing the distribution and abundance of acridid population in general.

This study on seasonal variation indicates that in *Acrida exaltata* Walk. Populations indirectly affected by climatic factors through their effects on the sexual activity of the adults. It is clear that mating is restricted or even curtailed during periods of cool, cloudy weather.

Acknowledgements

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LARVAL CULTURE OF THE HERMIT CRAB *CLIBANARIUS AEQUABILIS* VAR. *MERGUIENSIS* DE MAN (DECAPODA, ANOMURA, DIOGENIDAE) REARED IN THE LABORATORY[1]

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(*With seven text-figures*)

The paper describes the complete life history of an intertidal hermit crab, *Clibanarius aequabilis* var. *merguiensis*, as observed in the laboratory. The larvae pass through four zoeal stages and a glaucothoe stage. All the developmental stages are fully illustrated and described. Characters of generic importance are listed.

INTRODUCTION

The present paper deals with the complete larval history of *Clibanarius aequabilis* var. *merguiensis* de Man as observed in the laboratory.

MATERIALS AND METHODS

An ovigerous female of *C. aequabilis* var. *merguiensis* was collected on September 16, 1974 from a tide pool of Kinkade rocky shore along the west coast of India, and was kept in a glass trough containing filtered sea water until the larvae hatched out on 28th September 1974. The larvae were separated into groups of 5 per bowl with approximately 150 ml of sea water. Newly hatched *Artemia* nauplii were added as food. Every day the larvae were transferred to fresh sea water. Exuviae and the dead larvae were removed regularly and were preserved in a special preservative (Thakur 1960). During the course of the experiment the temperature ranged from 25° to 28°C and salinity about 25 ppt.

The larvae were dissected in 5% glycerine under a binocular microscope. All the drawings were prepared with the aid of a camera lucida. The total length of the larva was measured from the tip of rostrum to median posterior margin of telson. The carapace length was measured from tip of rostrum to postero-dorsal margin of carapace. The term 'stage' is used herein in the sense of instar or intermoult.

The eggs are oval, violet to pinkish (when young) turning transparent and pale when about to hatch; egg size ranged from 0.37-0.44 x 0.30-0.38 mm.

RESULTS

The larvae of *Clibanarius aequalibis* var. *merguiensis* de Man reached the glaucothoe after passing through four successive zoeal stages in about 22 days after hatching. A summary of the various instars and duration of instars is shown in Table 1.

TABLE 1

Larval stage	Duration in days
I zoea	6 — 8
II zoea	4 — 7
III zoea	5 — 8
IV zoea	6 — 9
Glaucothoe	None moulted to crab

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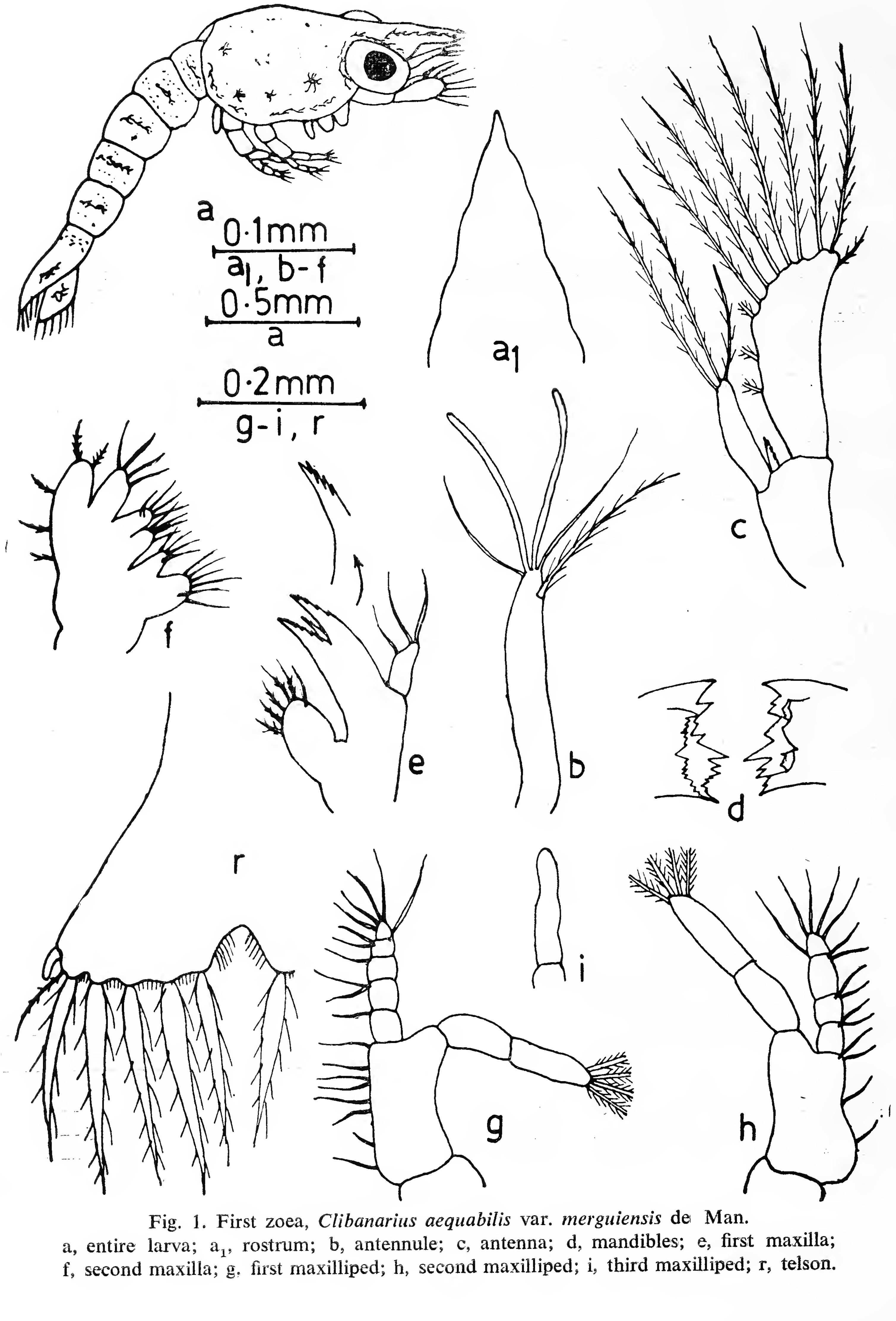

Fig. 1. First zoea, *Clibanarius aequabilis* var. *merguiensis* de Man.
a, entire larva; a_1, rostrum; b, antennule; c, antenna; d, mandibles; e, first maxilla; f, second maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped; r, telson.

Chromatophores:

The chromatophores of the larvae are of diffuse type, giving orange yellow to red appearance to the larvae. The chromatophores are stellate with mainly orange, crimson red and light yellow components.

Description of larval stages:

First Zoea (Fig. 1)

Carapace length: 1.0 mm; Abdomen length: 1.2 mm

Rostrum beak like, acutely pointed at the tip and broad at the base, projects beyond the antennule and antenna (fig. 1, a); eyes sessile; carapace smooth, rounded on postero-lateral angle, 4 exopod setae each on first and 2nd maxillipeds; third being rudimentary; abdomen nearly as long as carapace, inclusive of rostrum; telson process formula 7+7, 1st slightly laterally situated and blunt, finger-like.

Antennule (fig. 1, b) with 2 terminal aesthetascs and 2 unequal setae; inner ramus represented by a long, plumose seta. *Antenna* (fig. 1, c): Endopod nearly 2/3rd the length of scale, with 3 terminal setae; scale, long and narrow with 11 plumose setae; endopod and scale distinctly articulated to peduncle; peduncle with a minutely serrated ventral spine on the distal margin. *Mandibles* (fig. 1, d) asymmetrical and stout; ventral plate with 4-5 large but unequal teeth in the middle, whereas the dorsal provided with several unequal small teeth all along the edge. *First maxilla* (fig. 1, e): Coxal endite with 6 setae of which 3-4 simple and others bristle-like; basal armed with 2 serrated spines and one short spine-like seta; unsegmented palp with 2 terminal and 1 subterminal setae. *Second maxilla* (fig. 1, f): Coxal and basal endites bilobed; proximal of coxal with 5 terminal and single subterminal setae; distal with 3 terminal and 1 subterminal; proximal of basal with 4 and distal with 3 terminal and a short subterminal setae; endopod with 2 groups of 2 setae each; scaphognathite bears 5 marginal plumose setae. *First maxilliped* (fig. 1, g): Endopod nearly as long as exopod, 5-segmented, setation being, 1, 2, 1, 2 and 4 + 1 (outer) distalwards; exopod 2-segmented with 4 natatory setae; basis with 8 setae as in figure. *Second maxilliped* (fig. 1, h): Endopod 4-segmented, 3rd being the longest, setation, 2, 2, 2 and 4 + 1 (outer) distalwards; exopod as in first maxilliped; basis with 4 setae as illustrated. *Third maxilliped* (fig. 1, i) rudimentary and uniramous. *Abdomen* (fig. 1, a) 5-segmented, segments smooth and broader than long. *Telson* (fig. 1, r) broader than long, process formula 7 + 7; 1st finger-like process articulated and situated laterally; 2nd reduced 'anomuran' hair; 3rd to 7th, plumose setae; 4th being the longest, 7th alone spinose on the outer margin; posterior margin of telson and median notch fringed with microscopic hairs.

Second Zoea (Fig. 2)

Carapace length 1.2 mm; Abdomen length 1.6 mm

Larvae increase in size; eyes stalked; number of setae on exopod of first two maxillipeds increased to 6; exopod of third maxilliped well developed with 5 setae, but endopod bud-like; telson process formula 8 + 8.

Antennule (fig. 2, b): Peduncle with 3 long plumose setae at its distal margin; outer ramus now distinctly articulated with peduncle, bearing 2 aesthetascs (of which one is quite prominent) and 3 unequal setae. *Antenna* (fig. 2, c): No considerable change over previous stage. *Mandible* (fig. 2, d): No change except for a slight increase in size and prominence of teeth. *First maxilla* (fig. 2, e): Coxal endite and endopod unchanged; basal now with 4 serrated spines and 2 short setae. *Second maxilla* (fig. 2, f): Coxal and basal endites

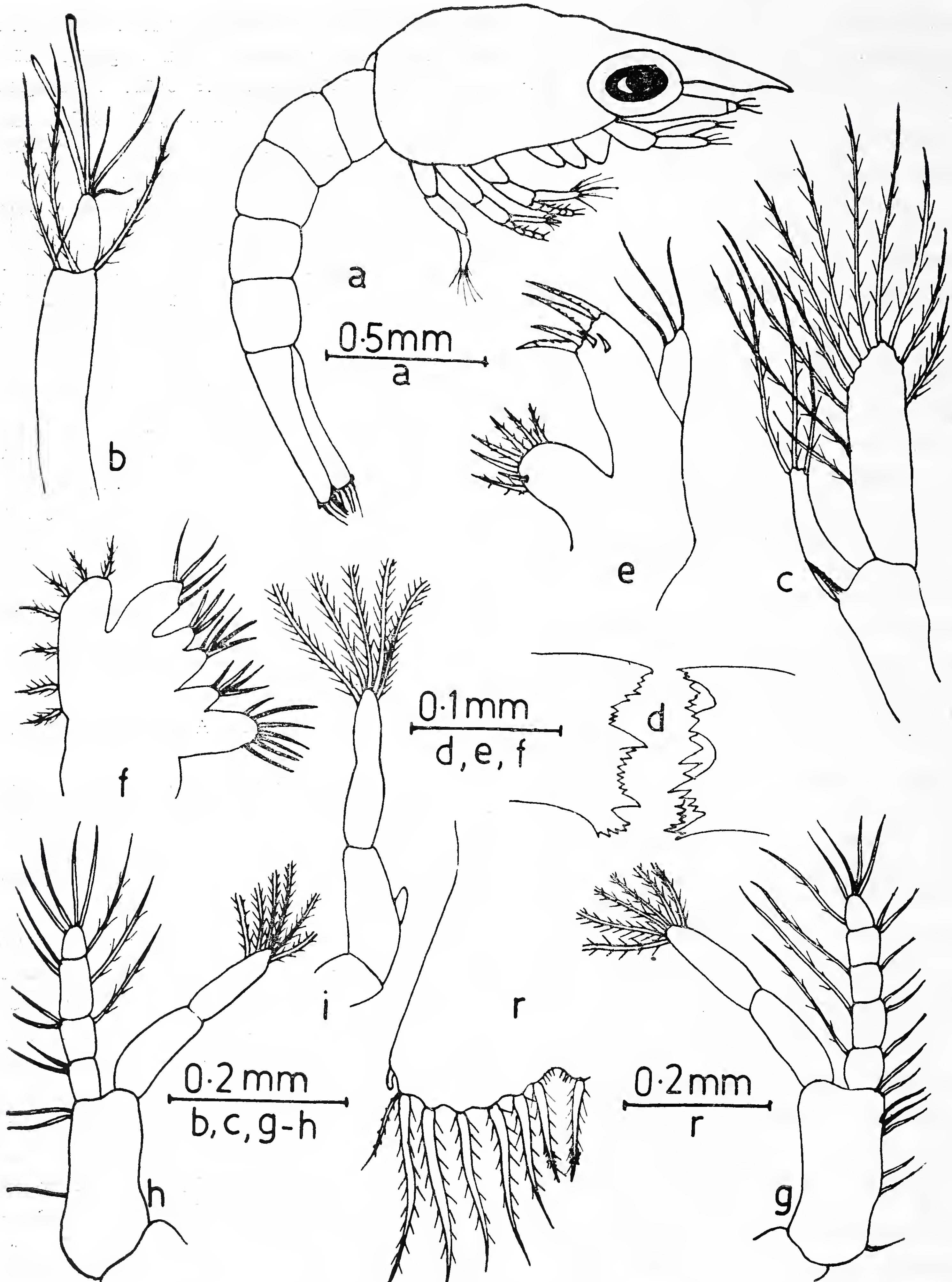

Fig. 2. Second zoea, *Clibanarius aequabilis* var. *merguiensis* de Man. a, entire larva; b, antennule; c, antenna; d, mandibles; e, first maxilla; f. second maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped; r, telson.

with 7 + 4 and 4-5 + 3 setae respectively; scaphognathite now with 6-7 marginal setae; no change in endopod. *First maxilliped* (fig. 2, g): Exopod with 6 natatory setae; addition of a plumose seta each on the outer margin of first 3 segments of endopod. *Second maxilliped* (fig. 2, h): Exopod as in 1st maxilliped; addition of 1 seta each on 2nd and 3rd segments of endopod. *Third maxilliped* (fig. 2, i): Exopod well developed, partially 2-segmented with 5 natatory setae; endopod as indistinct bud. *Telson* (fig. 2, r): Slightly broader than long; process formula 8 + 8; median pair being spinulose distally.

Third Zoea (Fig. 3)

Carapace length: 1.4 mm; Abdomen length: 1.7 mm

Zoeae increase considerably in size and can be distinguished by the following characters: antennal endopod with a single seta; 3rd maxilliped now with 6 setae; 4 pairs of pereiopod buds developed; abdomen 6-segmented; telson process formula 8 + 1 + 8, 4th process reduced to a spine; uropod biramous.

Antennule (fig. 3, b): Peduncle with 4 long, plumose and 4 fine hair-like setae distally; inner ramus separated from peduncle; outer now with 3 aesthetascs and 4 unequal setae. *Antenna* (fig. 3, c): Endopod elongated, reaching upto the tip of the scale and with a single seta; scale with 12 setae. *Mandible and first maxilla* (fig. 3, d & e) as in previous stage. *Second maxilla* (fig. 3, f): Coxal and basal endites with 8 + 4 and 4 + 3 setae respectively; scaphognathite with 10 plumose setae; no change in endopod. *Maxillipeds* (fig. 3, g, h & i): No change in 1st and 2nd; exopod of 3rd with 6 natatory setae; endopod slightly elongated. *Pereiopods* (fig. 3, k): Four pairs of rudimentary buds clearly seen. *Abdomen* (fig. 3, a): Sixth segment separated from telson; *Telson* (fig. 3, r): Somewhat rectangular in shape; process formula 8 + 1 + 8; 4th process now reduced to an unarticulated spine; all the processes plumose except the 1st and 4th, somewhat spinose at the tip. *Uropods* (fig. 3, r) biramous, with a functional exopod and a rudimentary endopod; exopod with 8 plumose setae on its posterior margin; endopod present as bud.

Fourth Zoea (Figs. 4 & 5)

Carapace length: 1.7 mm; Abdomen length: 1.9 mm

This stage exhibits following advanced features over the previous stage: inner ramus of antennule now gets distinctly separated from peduncle; mandibular palp developed as rudimentary bud; 5 pairs of pereiopod buds; 4 pairs of pleopod buds; endopod of uropods functional.

Antennule (fig. 4, b): Peduncle now with 4 long plumose and 3 hair-like setae distally; inner ramus clearly separated and tip devoid of setae; outer with 3 aesthetascs and 4 unequal setae terminally. *Antenna* (fig. 4, c): Endopod 2-segmented, about $1\frac{1}{2}$ times longer than scale and with a single terminal seta. Scale with 13 marginal setae. *Mandible* (fig. 4, d): Palp developed as bud. *First maxilla* (fig. 4, e): No change except for the addition of a plumose seta on the coxal endite. *Second maxilla* (fig. 4, f): Coxal and basal endites with 8-9 + 3 and 4-5 +5 setae respectively; endopod being unchanged; scaphognathite fringed with about 14 setae. *Maxillipeds* (fig. 5, g, h & i): 1st and 2nd unchanged; endopod of 3rd segmented with a terminal seta. *Pereiopods* (fig. 5, k) represented as 5 pairs of elongated buds showing partial segmentation, 1st being chelate and 5th subchelate. *Abdomen* (figs. 4, a & 5, 1): Four pairs of pleopods present as buds from 2nd to 5th segments. *Telson* (fig. 5, r): Process formula 8 + 1 + 8; 4th process still present, but reduced. *Uropods*

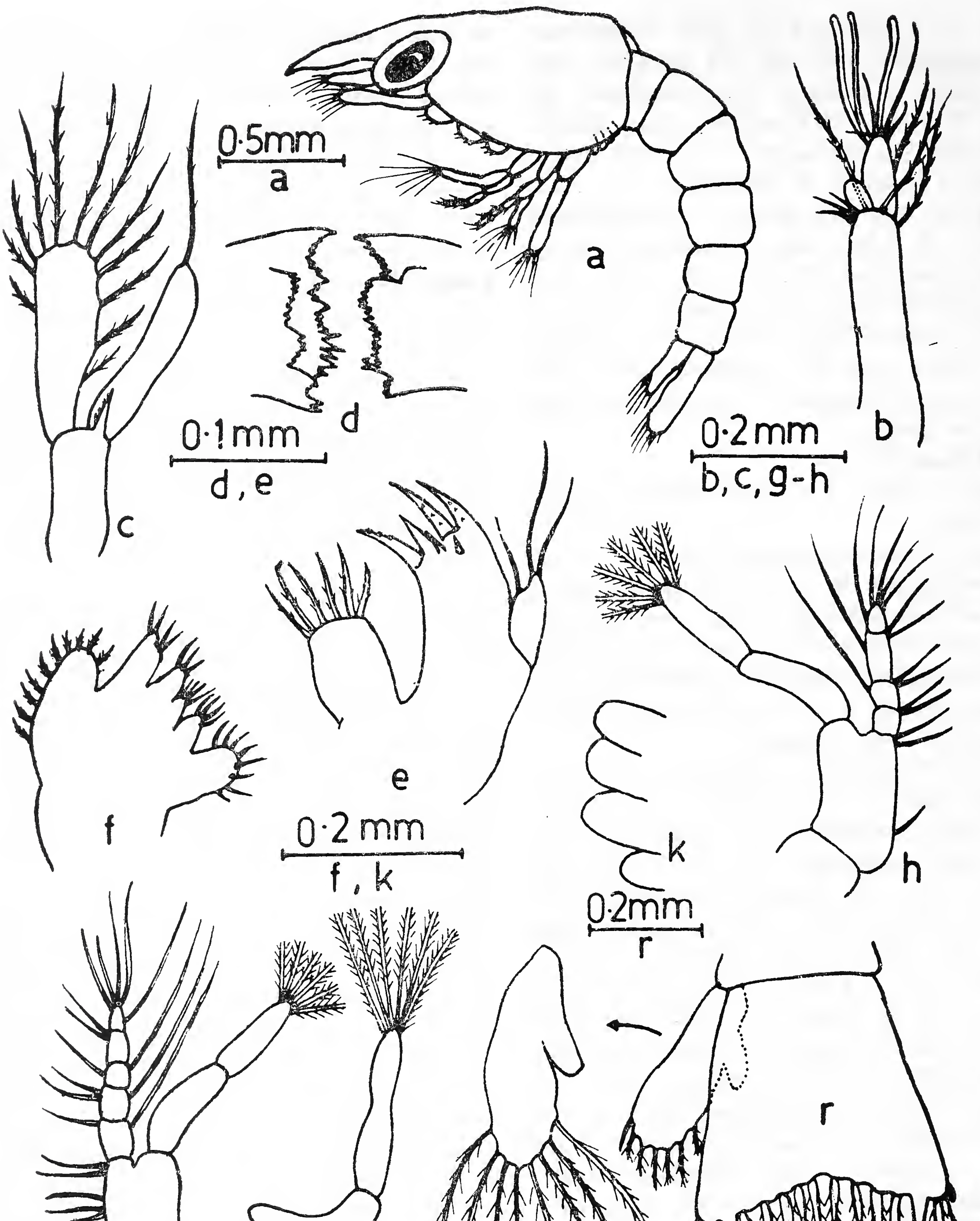

Fig. 3. Third zoea, *Clibanarius aequabilis* var. *merguiensis* de Man.
a, entire larva; b, antennule; c, antenna; d, mandible; e, first maxilla; f, second maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped; k, pereiopods; r, telson.

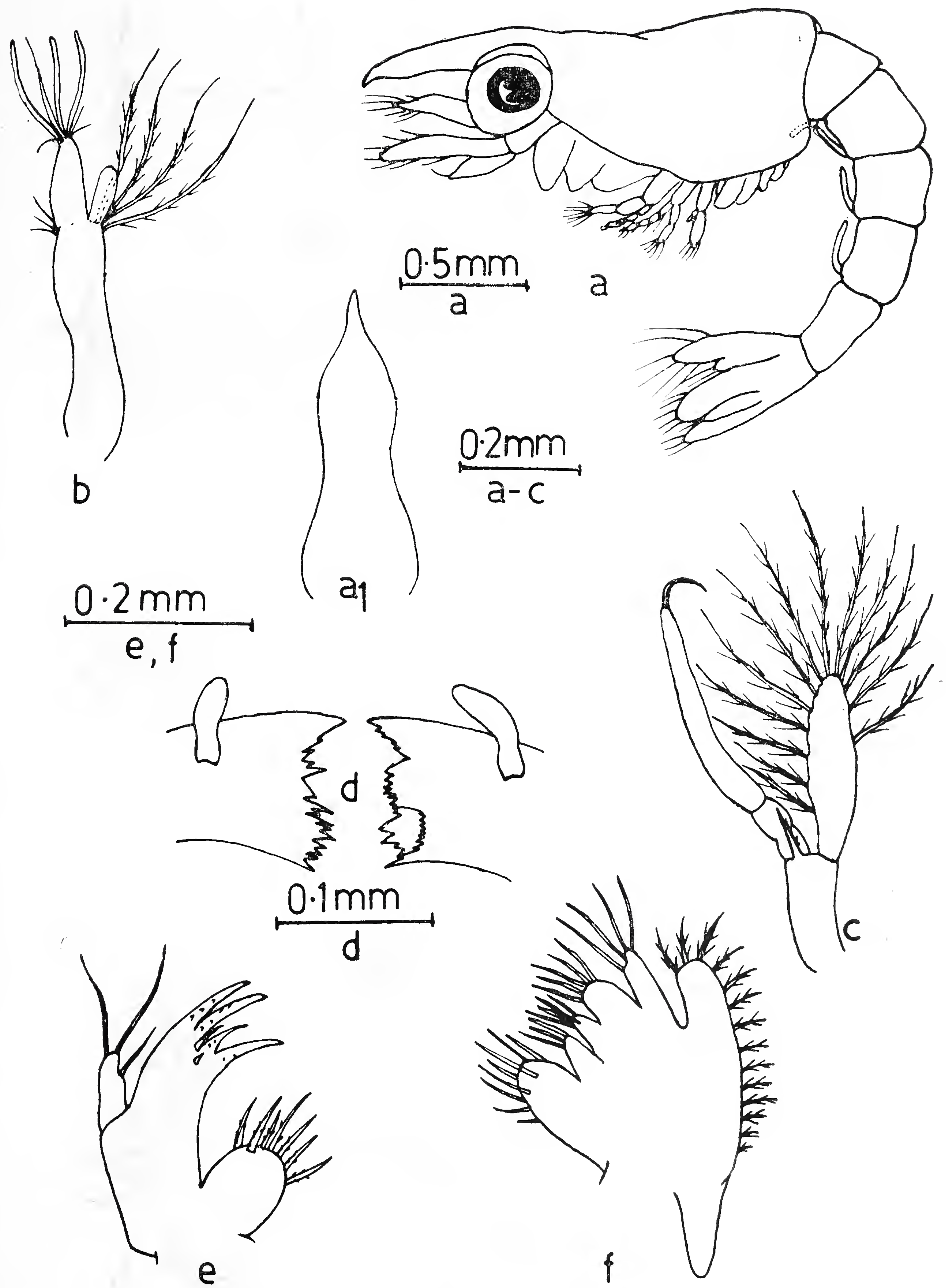

Fig. 4. Fourth zoea, *Clibanarius aequabilis* var. *merguiensis* de Man.
a, entire larva; a_1, rostrum; b, antennule; c, antenna; d, mandibles; e, first maxilla; f, second maxilla.

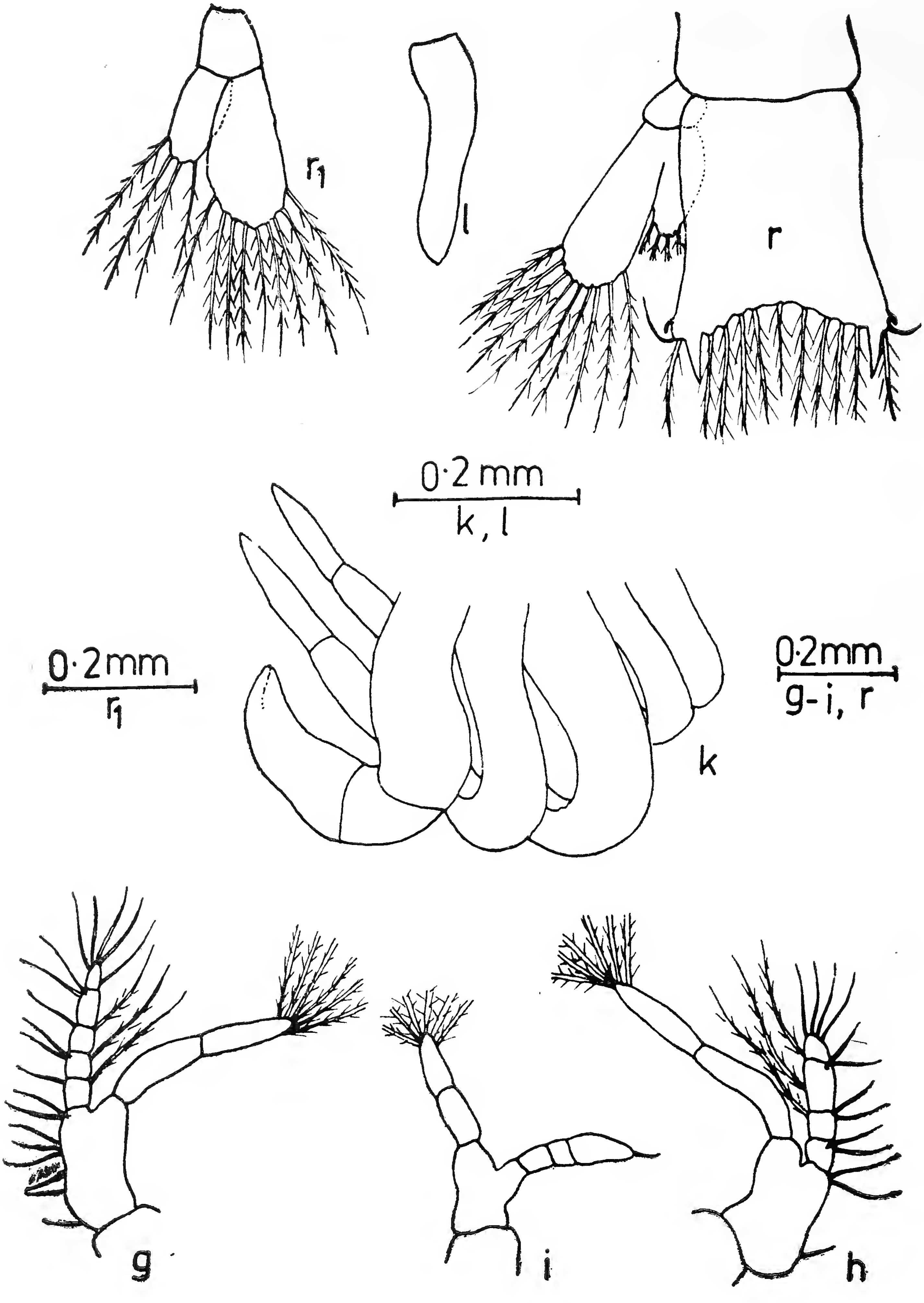

Fig. 5. Fourth zoea, *Clibanarius aequabilis* var. *merguiensis* de Man.
g, first maxilliped; h, second maxilliped; i, third maxilliped; k, pereiopods; 1, pleopod; r, telson and r_1, uropods.

(fig. 5, r_1): Both exopod and endopod functional; exopod rather oval with 9-10 plumose setae; endopod with 4-6 setae.

Glaucothoe (Figs. 6 & 7)

Carapace length: 1.2 mm; Abdomen length: 1.9 mm

Rostrum short and broad at the base; abdomen about $1\frac{1}{2}$ times the length of carapace; chelipeds more or less equal; eye-stalks nearly twice as long as broad and almost reaching the distal end of antennular and antennal peduncle; ophthalmic scales small; fourth and 5th pereiopods smaller, subchelate and chelate respectively; 4 pairs of biramous pleopods; uropods slightly unequal.

Antennule (fig. 6, b): Peduncle 3-segmented, first segment somewhat globular, second and third segments somewhat cylindrical; outer ramus 5-segmented with 0, 5-6, 4 and 2 aesthetascs respectively on 1st to 4th segments, distalwards and 3-4 setae on 5th, in addition to few simple setae on 2nd and 3rd segments. *Antenna* (fig. 6, c): Peduncle 5-segmented; scale with 3 outer marginal and 2 distal setae, reaching nearly to the distal margin of 4th segment, with a pointed process on the outer distal angle; 9-segmented flagellum with 0, 3, 3, 3, 4, 3, 4, 5 and 7 setae from 1st to 9th segments distalwards. *Mandible* (fig. 6, d): As in adult; palp 3-segmented with about 12 bristle-like setae distally on terminal segment. *First maxilla* (fig. 6,e): Both coxa and basis membranous bordered with setae and plumose hairs; coxa with about 19 setae and basis 15-17 setae; inner margin of basis with 2 simple setae; endopod short and unsegmented with a short knob-like projection terminally on the outer side bearing a single seta; inner margin with 1 or 2 setae. *Second maxilla* (fig. 6, f): Similar to adult except that palp is simple; scaphognathite well developed and fringed with about 50 setae. *First maxilliped* (fig. 6, g): As in adult, except that exopod lacks the terminal flagellated portion. *Second maxilliped* (fig. 6, h): Of the endopod segments merus is the longest as in adult; exopod shows distinct flagellated and nonflagellated portions, flagellated portion 3-segmented bearing 5 to 6 plumose and a few simple distal setae. *Third maxilliped* (fig. 6, i): Distal 2 segments of endopod bear many setae, remaining 3 segments with $2+2$, $2+1$ and $4+1$ setae distalwards; the flagellated portion of exopod do not show clear segmentation and with 6 plumose setae terminally. *Pereiopods* (fig. 7, k_2-$_5$): *First pair of chelipeds* (fig. 7, k_1), as in adult, distinctly chelate, in almost horizontal plane; merus is the longest segment; carpus somewhat triangular, 1/3rd the length of merus; propodus longer than broad and devoid of tubercles; fingers hoofed; dactylus more or less equal to propodus in length with slightly curved but somewhat hoofed tip; few scattered setae on all segments but no spines and tubercles. *Second pereiopods* (fig. 7, k_2), more or less similar; segments long and cylindrical; propodus is the longest segment; carpus 1/2 the length of propodus; dactylus nearly $\frac{3}{4}$th the length of propodus, unlike in adult wherein dactylus is 1.7 times propodus, with 2-3 spinules on its posterior margin. *Third pereiopods* (figs. 7, k_3) similar to the second leg except for 2-3 spinules on its posterior margin. *Fourth pereiopods* (fig. 7, k_4) quite small, smaller than fifth leg; merus and carpus more or less of equal length; propodus as broad as long and with about 4-6 pectinate granules and tufts of setae distally; dactylus claw-like with no spines but bearing tufts of setae and a long seta. *Fifth pereiopods* (fig. 7, k_5) minutely chelate; merus being the longest segment; carpus nearly 2/3rd the length of merus and bears few setae on either margins; anterior part of propodus and proximal part of dactylus show corneous granules; the

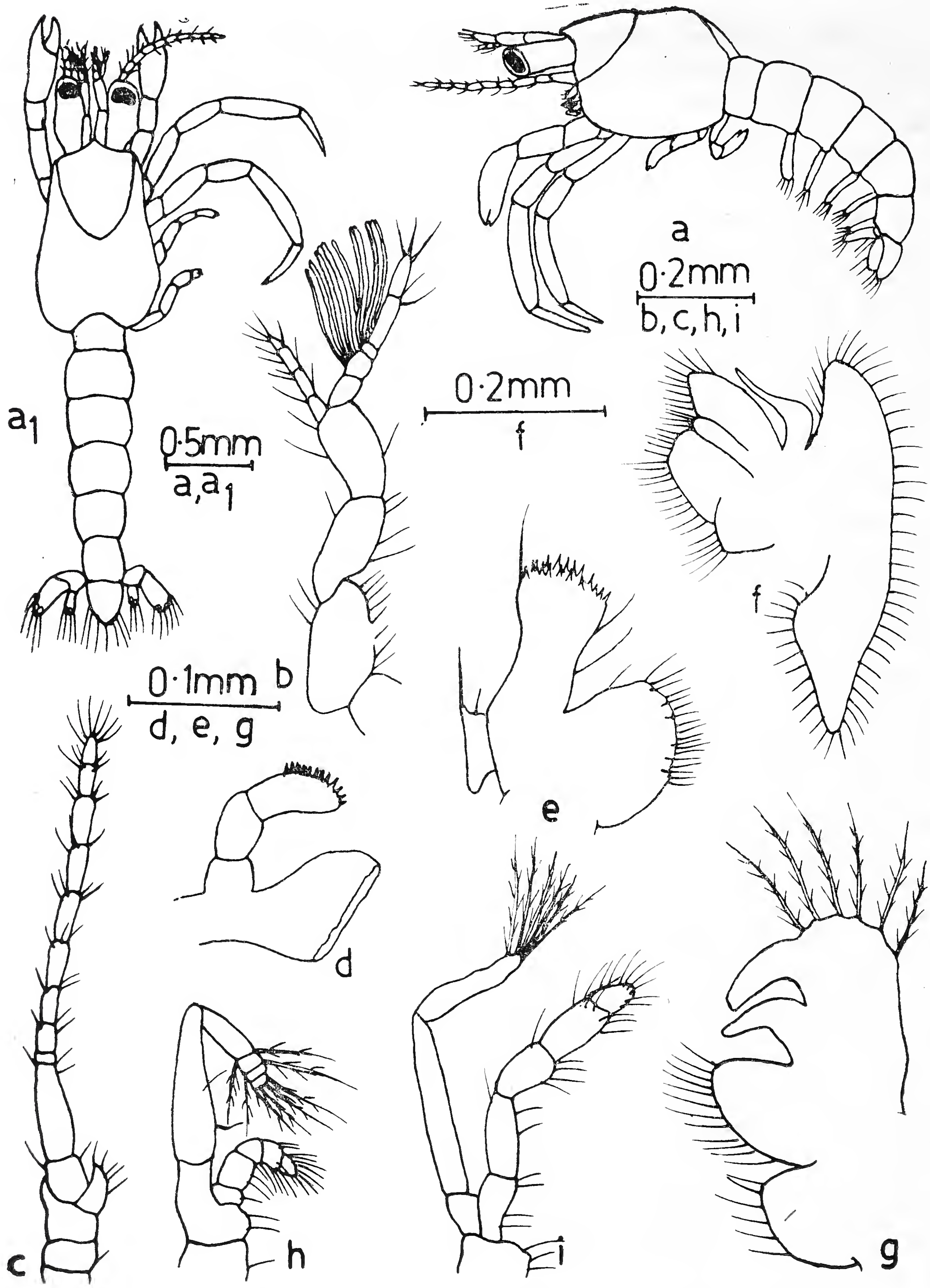

Fig. 6. Glaucothoe of *Clibanarius aequabilis* var. *merguiensis* de Man.
a, lateral view of entire larva; a_1, dorsal view of entire larva; b, antennule; c, antenna; d, mandible; e, first maxilla; f, second maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped.

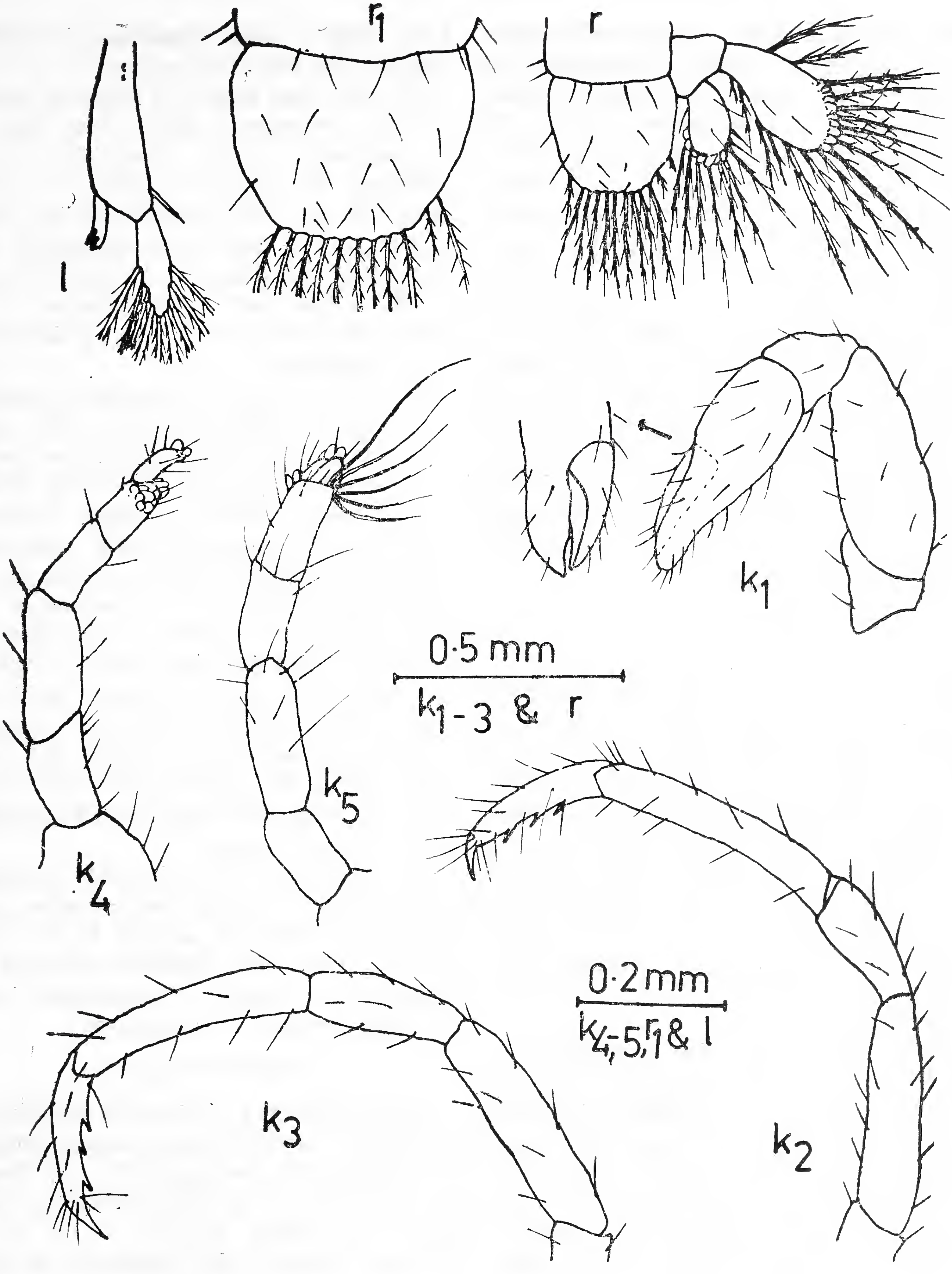

Fig. 7. Glaucothoe of *Clibanarius aequabilis* var. *merguiensis* de Man.
k_1, cheliped; k_2, second pereiopod; k_3, third pereiopod; k_4, fourth pereiopod; k_5 fifth pereiopod; l, pleopod; r, telson and uropod; r_1, telson

latter forming a chelate structure with dactylus; very long setae both on propodus and dactylus. *Abdomen* (fig. 6, a) nearly $1\frac{1}{2}$ times as long as carapace; 6-segmented; 2nd to 5th segments with a pair of pleopods each. *Pleopods* (fig. 7, l) biramous with a long peduncle; a setose exopod and 2 hooks in the inner margin of endopod. *Telson* (fig. 7, r) somewhat obtuse, slightly broadening anteriorly, with about 9 plumose setae on its plain posterior margin and 2 pairs of small simple setae laterally and dorsally and a pair of submarginal setae posteriorly. *Uropods* (fig. 7, r) well developed; both the rami being somewhat rectangularly triangular and armed with corneous granules on the posterior end; with 14 plumose setae on the posterior and inner lateral margins of exopod and about 11 on posterior margin of endopod.

Discussion

Based on the hitherto described larvae, the features of generic importance of *Clibanarius* may be summarised as under for first zoeal stages: carapace and abdominal somites smooth; rostrum long, broad at the base, blunt or acutely pointed at the tip; reaching beyond the antennule and antenna, beak-like; antennal scale without a terminal spine, endopod with three long plumose setae; telson deeply notched; first process laterally situated, blunt, finger-like except for *C. erythropus* wherein it is a small spine.

Of the three species wherein published information on the laboratory reared larvae in the genus *Clibanarius* is available, the larvae of *C. vittatus* (Lang & Young 1977) pass through 5 zoeal instars, rarely 4, whereas, *C. infraspinatus* (Shenoy & Sankolli 1977) and *C. padavensis* (Shenoy & Sankolli 1975) pass through 4 zoeal instars before a glaucothoe. Thus, stage to stage comparison is possible with only the latter two species.

The first stage larva of *Clibanarius aequabilis* var. *merguiensis* differs from those of *C. padavensis* and *C. infraspinatus* in the following: the posterior border of telson along with the notch fringed with fine hairs; exopods of first and second maxillipeds two-segmented; outer margin of endopod of second maxilla without hairs. Also, the larvae of the present species differ from other larvae in setation of appendages.

The third zoea of *Clibanarius aequabilis* var. *merguiensis* differs from those of *C. padavensis* and *C. infraspinatus* in the telson, having an unarticulated spine as the fourth process in the present species as against a minute tubercle in *C. infraspinatus* and *C. padavensis.*

Shenoy & Sankollii (1977) consider the reduced fourth process of *C. infraspinatus* as a generic character. However, in the larvae of *C. vittatus* (Lang & Young) and *C. aequabilis* var. *merguiensis* (present species) the fourth process changes into an unarticulated spine and retains its prominence throughout the zoeal stages. Hence the reduced fourth telson process in *C. infraspinatus* should not be considered as a generic feature.

The glaucothoe of *Clibanarius aequabilis* var. *merguiensis* exhibits generic features summarised by Shenoy & Sankolli for *C. infraspinatus* (1977). The differences observed are mainly in the armature of appendages, hence a detailed comparison is not made.

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TOURIST ACTIVITY AND BEHAVIOUR OF THE LEOPARD *PANTHERA PARDUS FUSCA* (MEYER, 1794) IN THE RUHUNA NATIONAL PARK, SRI LANKA[1]

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(*With two text-figures*)

The activity of the leopard (*Panthera pardus fusca*) was carefully monitored in three areas of Block I of the Ruhuna National Park, Sri Lanka, from July 1979 to June 1980. In 67 hours of observations there were 16 sightings. Despite few records, the following conclusions were made:— (a) leopards had two activity peaks, early morning and late evening; (b) leopards were seen more frequently in the drought months; (c) leopards were not seen with the same frequency in the different areas; (d) sightings were short, mostly 10 seconds or less, and (e) most sightings caused obvious disturbance to the leopards. Tourist activity in the Park may account for these characteristics of leopard behaviour.

INTRODUCTION

In Sri Lanka the leopard, once widespread, is now mainly limited to the country's major National Parks, and there are probably no more than a few hundreds remaining in the country (Santiapillai *et al.* 1982).

The National Parks are visited by large numbers of tourists and the wildlife authorities are concerned that these visitors may be having harmful effects such as altering the behaviour and distribution patterns of ungulates and carnivores.

In the Ruhuna National Park the leopard is confined mainly to forested areas, and direct observations on the animal are not easy. Sightings are frequently brief and restricted to early morning and late afternoon periods of activity. The present study reports an attempt to make brief sightings of the leopard of quantitative value so that reasonable inferences may be made concerning its behaviour and abundance. In addition, good quantitative data on leopard sightings may be useful for measuring future changes in leopard behaviour and/or abundance.

THE STUDY AREA

The Ruhuna National Park is situated in the arid south-east corner of Sri Lanka (formerly Ceylon). The annual rainfall is less than 1000 mm unequally spread throughout the year. There is a prolonged drought from June to September, a marked rainy season from October to December and intermittent rains from January to May. The Park is 1,160 km^2 and is

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divided into several Blocks. The present study was carried out in Block 1, the main tourist area of the Park which currently attracts about 90,000 visitors each year. Most tourists enter in the early morning or late afternoon. The vegetation of Block 1 consists principally of climax riverine forest, thorn scrub (degraded climax forest) and grasslands (edaphic climaxes maintained by seasonal floodings and by ungulate and small mammal grazing pres-

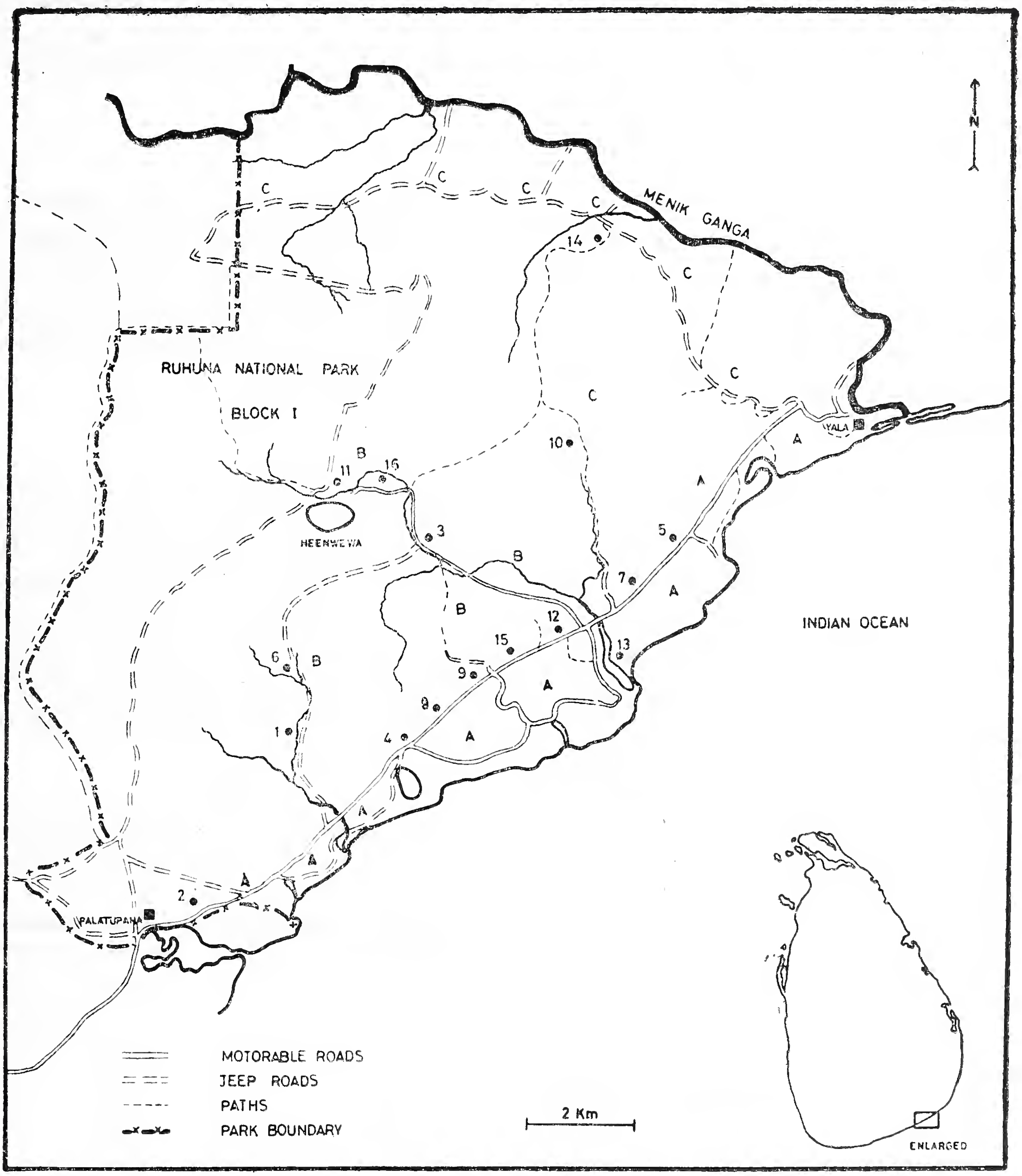

Fig. 1. Map of Block I, Ruhuna National Park, Sri Lanka showing the locations (●) of the leopard sightings in the main study Areas A, B & C.

sure). The predominant vegetation is a dense thorny scrub through which visibility rarely exceeds 20 m and is frequently much less. The grasslands of Block 1 are found throughout the area although more commonly in the central and coastal regions. They are small in size, the largest being about 0.5 km^2.

The Park supports a large biomass of herbivores, the most important being spotted deer (*Axis axis* Erxleben), water buffalo (*Bubalus bubalis* L.), elephant (*Elephas maximus* L.), wild pig (*Sus scrofa* L.), sambar (*Cervus unicolor* Kerr) and the black-naped hare (*Lepus nigricollis* F. Cuvier). The leopard is the only large carnivore in the Park and in Sri Lanka. For a fuller description of the Ruhuna National Park see Comanor (1971) and Mueller-Dombois (1968 and 1972).

Methods

All observations were made between July 1979 and June 1980. During the course of our studies on the herbivores of the Park (Balasubramaniam *et al.* 1980, Santiapillai and Chambers 1980, 1981 and 1982, Santiapillai *et al.* 1981 and 1982) we travelled extensively in Block 1. For the purposes of studying the leopard population, Block 1 was divided into three Study Areas A, B and C (Fig. 1). Area A comprised the main road running the length of Block 1 from the entrance at Palatupanu to its termination at the Yala bungalow and all roads east of this. Area B comprised the central roads and Area C the northern roads. A fourth major road running along the western side of Block 1 was not surveyed frequently enough to be included in this analysis although leopards have been seen there. Each day was divided into 2-hour time intervals from 0600 to 1800 with an additional interval later than 1800 h. The amount of time spent travelling in each Study Area was carefully logged and whenever a leopard was sighted the following information noted:- date, time, duration of sighting, minimum distance from the leopard and its behaviour during the sighting. Every effort was made to reduce disturbance during the sighting and each sighting was continued until the leopard disappeared from view.

Results

The total observation time within the Park was 4020 minutes (67 hours) and there were 16 leopards sighted (1/4.2 h). For ease of comparison, sighting frequencies are reduced to a standard unit of number of sightings per hour of observation.

(a) *Pattern of daily sightings*

The total amounts of time spent on the look-out for leopards in each time period, together with the number and frequency of sightings, are given in Table 1. The data show two peaks of activity each day, a smaller one between 0600 and 0800 h (0.43 sightings/h) and a second larger one after 1800h with a frequency of sightings (0.79/h) double that of the morn-

Table 1

Number and frequency of leopard sightings in each time interval, Ruhuna National Park, July 1979 to June 1980

Time interval	Minutes of observations	Number of sightings	Frequency of sightings (no./h)
06.00-08.00	415	3	0.43
08.00-10.00	820	1	0.07
10.00-12.00	475	1	0.12
12.00-14.00	385	0	—
14.00-16.00	340	0	—
16.00-18.00	830	1	0.07
From 18.00	755	10	0.79

ing. The leopards in Block 1 were therefore mainly active after 1800h, and most of these sightings were made after sunset (about 1830 h). There may also be considerable activity before 0600 h. The activity peaks, at least during the daylight hours, were very short indeed. Between 0800 and 1800 h there were only three leopard sightings in 2850 minutes (0.06/h) and none between 1120 and 1755 h.

(b) *Seasonal variations in sightings*

The frequency of leopard sightings during the dry season, wet season and the period outside the peak dry season are given in Table 2.

TABLE 2

SEASONAL VARIATION IN THE FREQUENCY OF LEOPARD SIGHTINGS, RUHUNA NATIONAL PARK, JULY 1979 TO JUNE 1980

Season	Minutes of observations	Number of sightings	Frequency of sightings (no./h)
Peak dry season (July/Aug)	920	7	0.46
Peak wet season (Nov/Dec)	815	3	0.22
Period outside peak dry season (Nov/June)	3100	9	0.18

These frequencies varied with season. Leopards were seen most frequently during the drought months of July and August (0.46/h). During the wet season (November and December) sightings were 0.22/h and for the whole of the period outside the drought. 0.18/h. It was therefore apparent that leopard behaviour varied between dry season and the rest of the year.

(c) *Frequency of sightings in the Study Areas*

The total observation times together with the number and frequency of sightings in each of the three Study Areas are given in Table 3.

TABLE 3

VARIATION IN THE FREQUENCY OF LEOPARD SIGHTINGS IN THE STUDY AREAS OF RUHUNA NATIONAL PARK, JULY 1979 TO JUNE 1980

Area	Minutes of observations	Number of sightings	Frequency of sightings (no./h)
A	2415	9	0.22
B	890	5	0.33
C	715	2	0.17

Leopards were seen most frequently in Area B (0.33/h) and least in Area C (0.17/h). It was not possible (because of the few sightings and seasonal and daily variation in sighting frequencies) to assess whether or not the different rates from the Areas reflected chance observations or real differences in leopard behaviour and/or abundance. A possible indication of the differences between Areas A and B was the frequency of early morning sightings (0600 to 0800 h). In Area A no sightings were made during 190 minutes, whereas in Area B, 3 leopards were seen in 225 minutes. Similarly nearly all night sightings (after dusk) were in Area A. These observations tend to suggest that leopards avoided the busy roads of Area A during the daylight hours but came to them after sunset once the tourists had left the Park.

(d) *Duration of sightings*

The duration of each of the 16 sightings is shown diagrammatically in Fig. 2. The total duration of all 16 sightings was 896 seconds and the average 56 seconds. If the one long sighting of 600 seconds is excluded, the average duration of the remaining 15 was 20 seconds.

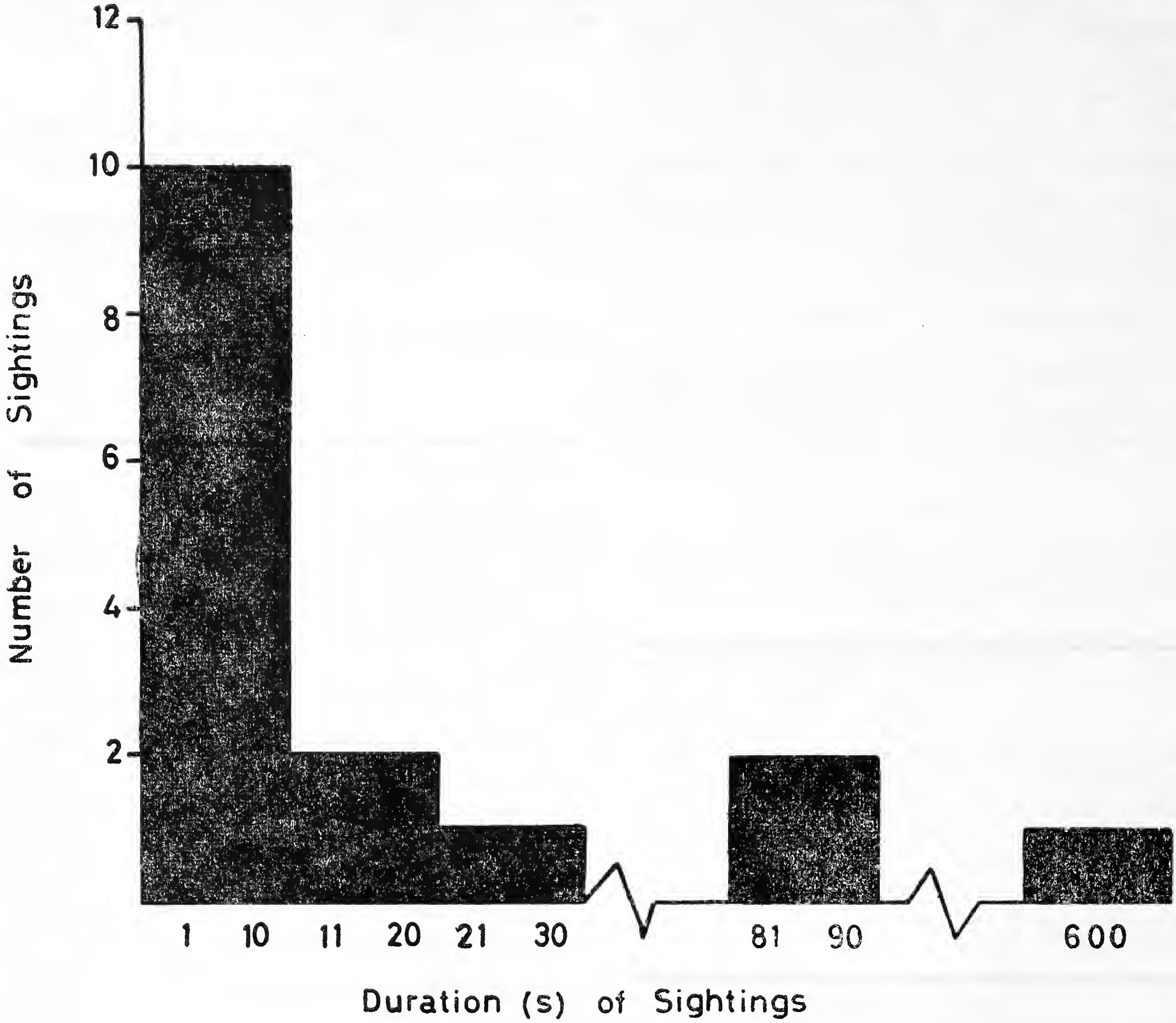

Fig. 2. Histogram showing the duration and frequency distribution of leopard sightings in the Ruhuna National Park, Sri Lanka, from July 1979 to June 1980.

Ten of the sightings were of 10 seconds or less. These generally very short sightings were in marked contrast to the long ones noted by Eisenberg and Lockhart (1972) and Muckenhirn and Eisenberg (1973) that averaged from 8 to 10 minutes in the Wilpattu National Park, Sri Lanka.

Of the 16 sightings there were 12 (75%) in which the leopard was obviously alarmed by us. In the remaining 4 the leopard was apparently unconcerned by the sometimes close encounters with the vehicle. On two occasions leopards strolled with 5 m of the jeep without apparently being aware of its presence.

Discussion

The leopard sightings documented here form a part of our studies on the fauna of the Ruhuna National Park. In anticipation of infrequent sightings we attempted to collect the data in such a way that it would be possible to draw conclusions about leopard behaviour, possible disturbance by tourists and to provide baseline information for comparison with future studies. During the year we recorded only 16 sightings in 67 hours of travels along the roads and tracks of the Park. Although this was not an ideal data base from which to make interpretations, several tentative conclusions can be drawn.

Firstly, leopards had morning (06.00 to 08.00) and evening (after 18.00) activity peaks. Between these periods there was very little observed activity. Such a daily behaviour pattern is typical of large carnivores. However the daylight activity peaks were shorter than those observed by Eisenberg and Lockhart (1972) in Wilpattu National Park, Sri Lanka. This had considerably fewer visitors than Ruhuna. It was possible therefore that daytime leopard activity in Ruhuna was curtailed by the early morning and late evening rush of visitors to the Park. More detailed studies would be required to show if leopards were active in the daytime but in areas away from the roads.

The results also show that leopards were seen more frequently during the July/August drought than at any other times of the year. One possible reason for this is that Ruhuna was closed to visitors at this time. Consequently very few vehicles were in the Park and the leopards were less frequently disturbed. Since the normal reaction of the leopard on seeing or hearing a vehicle was to disappear quickly into the adjacent scrub, it follows logically that the fewer vehicles in the Park the greater the chance of seeing leopards on or by the roadside. The drought season was also the leopard breeding season (Santiapillai *et al.* 1982) and therefore the animals may have been more active and wider ranging at this time which could account for more frequent sightings.

Other possible explanations for increased frequency of sightings at this time — loss of leaves by much of the scrub vegetation and changes in prey distribution — were unlikely to account for them. This was because all sightings were in open spaces — on roads, verges or grasslands and therefore unaffected by increased visibility into the scrub. Similarly during the drought one of the leopard's main prey species (spotted deer) moved into the scrub away from the roads (Balasubramaniam *et al.* 1980). If the leopards followed them closely, reduced sightings would be expected at this time.

The average duration of leopard sightings in Ruhuna was 56 seconds and the majority were 10 seconds or less. These short observation periods were undoubtedly due to the facts that virtually all sightings took place on or by roads and that the leopards moved quickly into the scrub when disturbed. Large numbers of vehicles travelling within the Park therefore virtually ensured that very few leopards would be seen.

The affinity of leopards for roads has long been documented (Storey 1907). The results of this study suggest that at Ruhuna this affinity was such that daily and seasonal behaviour patterns were to some extent at least geared to human activity on the roads.

The data collected during this study gave no information on the density of leopards in Ruhuna. The frequency of leopard sightings however, especially when related to time of the

day and locality, provide baseline information that can be used to monitor any future changes in numbers. Any significant increase or decrease in the leopard numbers would be expected to show up as corresponding changes in the frequency of sightings during a similar future survey, providing the behaviour of the leopards was unchanged.

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SOME OBSERVATIONS OF SCARCE BIRDS IN NEPAL[1]

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R. GRIMMETT[4]

Sightings of three species of birds previously unrecorded in Nepal are documented. Brief details of a further eleven species of ornithological significance to Nepal are also presented.

INTRODUCTION

From December 1978 to February 1979 the authors, R. Filby, C. Murphy and L. Norton visited Nepal to observe birds. C. Murphy and N. J. Redman made a return visit from April to June 1979. During these two periods 585 species of birds were identified, three of which: Baer's Pochard *Aythya baeri,* Sanderling *Calidris alba* and Common Gull *Larus canus,* were recorded for the first time in Nepal. The main purpose of this paper is to document these sightings. Brief details are also given of other species seen for which there are very few previous Nepalese records or for which information on breeding or unusual behaviour was gathered.

A wide variety of habitats and altitude zones in central and eastern Nepal was visited. Areas of significant ornithological interest included the Jomosom trek (January), Helambu/Gosainkund trek (May), Kathmandu Valley, central tarai, Ilam district and Kosi Barrage. The latter proved to be of particular interest since many scarce species were found here, including all three new species for Nepal. We visited Kosi Barrage on four separate occasions, 10-13 February, 20-21 February, 17-20 April and briefly on 23-24 April. During these four short periods totalling eight full days, the majority of our time was spent in areas on the north side of the barrage.

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NEW SPECIES FOR NEPAL

BAER'S POCHARD *Aythya baeri* (Radde)

Baer's Pochard was first identified on 12 February 1979 when two males and one female were seen on open water just north of the Kosi Barrage amongst a flock of several hundred *Aythya* spp. On 20 February we saw this species again and counted at least 17 males and 3 females. Prolonged observation of both sexes was possible and comparisons were made with accompanying Tufted Duck *A. fuligula,* Common Pochard *A. ferina* and Ferruginous Duck (White-eyed Pochard) *A. nyroca.*

In shape Baer's Pochard was comparable to Ferruginous Duck and Common Pochard, and intermediate in size.

Males were readily identifiable by the combination of iridescent green head and rich chestnut breast, unlike any other *Aythya* species. Other features included white belly, dusky brown flanks, white under-tail coverts and gleaming white eye. Females were similar in coloration to the males but duller, the

dusky head showing only a slight greenish gloss. At a distance, female Baer's Pochard appeared confusingly similar to other female *Aythya* species. Common Pochard and Tufted Duck, however, both lacked white undertail coverts and Ferruginous Duck could generally be separated by its uniform chestnut colouration, less white on the belly and flanks, and smaller size.

Baer's Pochard breeds in eastern Siberia wintering primarily in eastern China. In the Indian sub-continent, Ripley (1982) states that it is an uncommon and erratic winter visitor to Manipur, Assam and associated states, Bangladesh and Bengal; also recorded from Bihar and Maharashtra. Ali and Ripley (1978) suggest that it may be less rare than records indicate. There are no previous records from Nepal and this species was not seen at Kosi in the subsequent three winters (C. and T. Inskipp *in litt.*).

SANDERLING *Calidris alba* (Pallas)

A single Sanderling was discovered at Kosi Barrage on 11 February 1979 feeding on a mudbank with nine Dunlin *Calidris alpina* and fifty Little Stints *C. minuta.* It was not seen on subsequent days.

In size it was considerably larger than Little Stint and about the same as Dunlin but with a shorter, straight bill. Bill and legs were black. The very pale plumage, pale grey above and pure white below, served to distinguish the bird at some distance. A small black shoulder patch and black primary tips were also noted, and in flight it showed a more prominent white wing bar than Dunlin or Little Stint. A distinctive feature was its rapid feeding action. All the observers are familiar with this species in Europe.

Sanderling breeds in the Arctic, wintering on coasts almost throughout the world. Although a regular winter visitor to the coasts of India, it has apparently not been previously recorded inland in the subcontinent (Ali and Ripley 1980). Our sighting constitutes the first record from Nepal.

COMMON GULL *Larus canus* Linnaeus

On 12 February 1979 a Common Gull was found amongst a group of Black-headed Gulls *L. ridibundus* resting on a sandbank at Kosi Barrage. It remained in the area all day and allowed direct comparison with the Black-headed Gulls and also with Brown-headed Gulls *L. brunnicephalus* and a single adult Slender-billed Gull *L. genei.* It was still present on 21 February. Despite its rarity in Nepal, Common Gull is a familiar bird in Europe and was readily identified by all the observers as a first-year bird.

In appearance it was an elegant, medium-sized gull with a rounded head and a small yellowish bill with a dark tip. The head, neck and underparts were white with some faint brownish markings on the sides of the breast and head. A pale whitish oval patch on the closed wing contrasted with the grey mantle. The protruding primaries were dark brown and the legs were pale yellowish. In flight it showed a broad whitish band across the inner wing, contrasting with the brown flight feathers. The tail was white with a broad dark terminal band.

The Common Gull was easily separated from all other gulls present by its size, shape and colour of bare parts. Black-headed Gull was noticeably smaller and slimmer with reddish bill and legs. Brown-headed and Slender-billed Gulls, although of similar size, were different in shape and also had reddish bills and legs. The only species of gull likely to cause confusion within the Indian subcontinent is the Herring Gull *L. argentatus,* but this species is considerably larger and deeper-

chested with a more angled head and much stouter bill. Its wings are broader and flight heavier.

Common Gull is a widely distributed and abundant holarctic species breeding across the northern palearctic and moving south in winter. Surprisingly it has rarely been recorded from the Indian subcontinent. It is not included in Ali and Ripley (1981) or Ripley (1982) and the only records from the Indian subcontinent of which we are aware are two individuals from the Punjab area of Pakistan: L. J. Djiksen, F. Koning and A. Vittery saw an adult at Rasul Barrage on 27 January 1974 and A. Vittery identified a first winter bird at Rawal Lake, near Islamabad on 17 February 1974 (A. Vittery, pers. comm.). Our sighting represents the first record from Nepal. Subsequently, an adult in winter plumage has been observed at Phewa Tal near Pokhara on 21 January 1981 (del-Nevo and Ewins 1981).

OTHER RECORDS OF OUTSTANDING INTEREST

FULVOUS WHISTLING DUCK (Large Whistling Teal) *Dendrocygna bicolor*

A single individual of this species was identified amongst a flock of 1500 Lesser Whistling Duck (Teal) *D. javanica* at Kosi Barrage on 12 February 1979. This record constitutes the only sighting of Fulvous Whistling Duck in Nepal this century. Although overlooked by recent authors, a Hodgson specimen from Nepal is listed by Sharpe (1894). The specimen is still present in the British Museum and was located by C. Inskipp in 1981. In the Indian subcontinent this species is scattered widely, but sporadically in many areas and everywhere rather scarce. It is apparently more common in Bengal and Bangladesh (Ali and Ripley 1978).

RUDDY SHELDUCK *Tadorna ferruginea*

A pair with 8 newly-hatched young was present on a lake at Gosainkund on 27 May 1979 at an altitude of approximately 4300 m. This represents the first positive breeding record for Nepal (R. L. Fleming Jr., pers. comm.).

WHITE-TAILED (SEA) EAGLE *Haliaeetus albicilla*

Seven birds were seen from December to February including three at Kosi Barrage. An adult at Begnas Tal near Pokhara on 2 January 1979 was seen to catch a Purple Gallinule (Purple Moorhen) *Porphyrio porphyrio* in flight. The gallinule was subsequently dropped and defied repeated attempts at recapture by diving. Attacks on flying birds are apparently rare (Cramp *et al.* 1980).

BLACK-TAILED GODWIT *Limosa limosa*

A flock of 29 was seen at Kosi Barrage on 18 April 1979. In the 19th century Hodgson obtained at least one specimen in April and five between mid-August and late October (no year given), from the Kathmandu Valley. He wrote: "small flocks feed by day on chours or moist cultivated plots". J. Scully obtained a specimen on 7 September 1876 or 1877 in the Kathmandu Valley (Scully 1879), stating that "the godwit is a winter visitant to the Nepal Valley, but does not appear to be common there". In this century, a single bird was observed in the Kathmandu Valley in August 1978 (Fleming *et al.* 1979) and a specimen was taken at Chobar on 30 August 1981 by H. S. Nepali. There have been at least five other records at Kosi Barrage in Spring since 1979 (C. and T. Inskipp *in litt.* 1983).

LITTLE OWL *Athene noctua*

A single Little Owl was found at Kagbeni in the upper Kali Gandaki Valley on 14-15 January 1979 at an altitude of approximately 2800 m. This species was first recorded in Nepal

in July 1978 when two specimens were collected in Dolpo (H. S. Nepali pers. comm.). It has been seen subsequently at Kagbeni and nearby at Muktinath by several observers (C. and T. Inskipp *in litt.* 1983).

INDIAN CLIFF SWALLOW *Hirundo fluvicola*

Up to ten birds were present at Begnas Tal near Pokhara on 3 January 1979. This constitutes the second record from Nepal, the first being a single bird at Kosi on 10 April 1975 (Fleming *et al.* 1979).. There have been at least five subsequent records (C. and T. Inskipp *in litt.* 1983).

RUFOUS-BELLIED ROBIN *Tarsiger* (*Erithacus*) *hyperythrus*

A pair was feeding young on 24-25 May 1979 at about 3500 m on the west side of the Gandak-Kosi watershed. The nest was not seen but was sited on or close to the ground at the side of a shady wooded ravine. A second female was found nearby. Fleming *et al.* (1979) state that the species is known from the Kosi-Gandaki watershed ridge eastward but there have subsequently been several records west to the Kali Gandaki (C. and T. Inskipp *in litt.* 1983). The nest is undescribed (R. L. Fleming, Jr., pers. comm.).

EYE-BROWED THRUSH (DARK THRUSH) *Turdus obscurus*

Two birds were identified at Kokarna in the Kathmandu Valley on 20 December 1978 amongst a flock of thrushes comprising five species. Excluding a Hodgson specimen of unknown origin this was the first record of this species for the Kathmandu Valley. All other records are from East Nepal (C. and T. Inskipp., pers. comm.).

DUSKY THRUSH *Turdus naumani*

An adult was found at Lete in the Kali Gandaki Valley on 22-24 January 1979 in the company of a flock of sixty Dark-throated Thrushes *T. ruficollis.* A second bird, duller in plumage and presumed to be in first winter plumage, was discovered on 4 February 1979 at Gokarna in the Kathmandu Valley, also amongst a flock of Dark-throated Thrushes. In the 19th Century at least two specimens were obtained by Hodgson in the Kathmandu Valley in January (Gray and Gray 1846, Seebohm 1881). The only subsequent reference to Dusky Thrush in Nepal is a report of large parties on Nagar Jong at about 1500 m in Spring 1948 and a few in the Kathmandu Valley the following winter (Proud 1949). There have been several individuals reported since our observations, in both the Kali Gandaki and Kathmandu Valleys (C. and T. Inskipp *in litt.* 1983). In the Indian subcontinent, Dusky Thrush is stated to be an irregular winter visitor, rare in the west and more frequent in the east (Ripley 1982).

YELLOW-BROWED TIT *Sylviparus modestus*

An occupied nest hole of a pair of Yellow-browed Tits was found on 2 May 1979 on the slopes of Phulchowki in the Kathmandu Valley, at an altitude of 2000 m. The pair was feeding young. This was only the third nest ever discovered of this species. Full details have already been published (Lohrl 1981).

SCARLET-BACKED FLOWERPECKER *Dicaeum cruentatum*

A male and two females were seen at Dharan in East Nepal on 21 April 1979. This is only the second record of this species in Nepal (Fleming *et al.* 1979).

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SPAWNING OF SOME IMPORTANT COLDWATER FISH OF THE GARHWAL HIMALAYA[1]

S. P. BADOLA[2] AND H. R. SINGH[3]

(*With a plate*)

The present study gives an account of the spawning of some important coldwater fish of the Garhwal Himalaya. Most of them have one breeding season and breed in summer, monsoon and postmonsoon months. However, *Schizothorax* species show a long spawning season (July to January) and their breeding is at a peak from September to November. *Puntius chilinoides* and *P. hexastichus* spawn twice a year during two different but relatively short spawning periods, May-July and December-January. Increased pH and flooding (turbidity) is necessary for the spawning of *Noemacheilus, Glyptothorax, Pseudecheneis* and *Tor* species of the Garhwal streams. High concentration of dissolved oxygen and relatively low pH are necessary for the spawning of *Schizothorax, Labeo* and *Barilius.* Besides flooding and varying values of pH and oxygen content of the waters, a varying suitable temperature is also necessary for the spawning of these species. The natural breeding grounds of these fishes are also disturbed by the transportation of timber in the Garhwal rivers.

There is little or no information available on the breeding habits of coldwater fishes of the Garhwal Himalayas. Hence this study was undertaken.

MATERIAL AND METHODS

The period of spawning as inferred by the presence of mature ova and testes in the body cavity was confirmed by actually finding the spawn, fry and fingerlings. In some cases the ova attached to stones, lying in a particular breeding place were collected and counted (Plate 1). The breeding site of a particular fish was decided by the occurrence of its eggs and fry in that place. The temperature, pH, depth, gradient, current, and dissolved oxygen of the water in the breeding ground were recorded. The specimens were collected and examined from different snow-fed and non-snow-fed rivers and streams.

This study was made in respect of the following fishes:

Schizothorax sinuatus (Heckel), *S. plagiostomus* (Heckel), *S. richardsonii* (Gray), *Tor tor* (Ham.), *T. putitora* (Ham.), *Labeo dyocheilus* (McClell.), *L. dero* (Ham.), *Barilius bendelisis* (Ham.), *B. vagra* (Ham.), *B. barna* (Ham.), *Puntius chilinoides* (McClell.), *P. hexastichus* (McClell.), *Noemacheilus montanus* (McClell.) *M. multifasciatus* (Day), *N. rupicola* (McClell). *Glyptothorax pectinopterus* (McClell.), and *Pseudecheneis sulcatus,* (McClell.).

1. **Schizothorax sinuatus, S. plagiostomus** and **S. richardsonii.** These species are most common in snow-fed rivers and streams of this region. It was found that they start spawning gradually from July and end in January.

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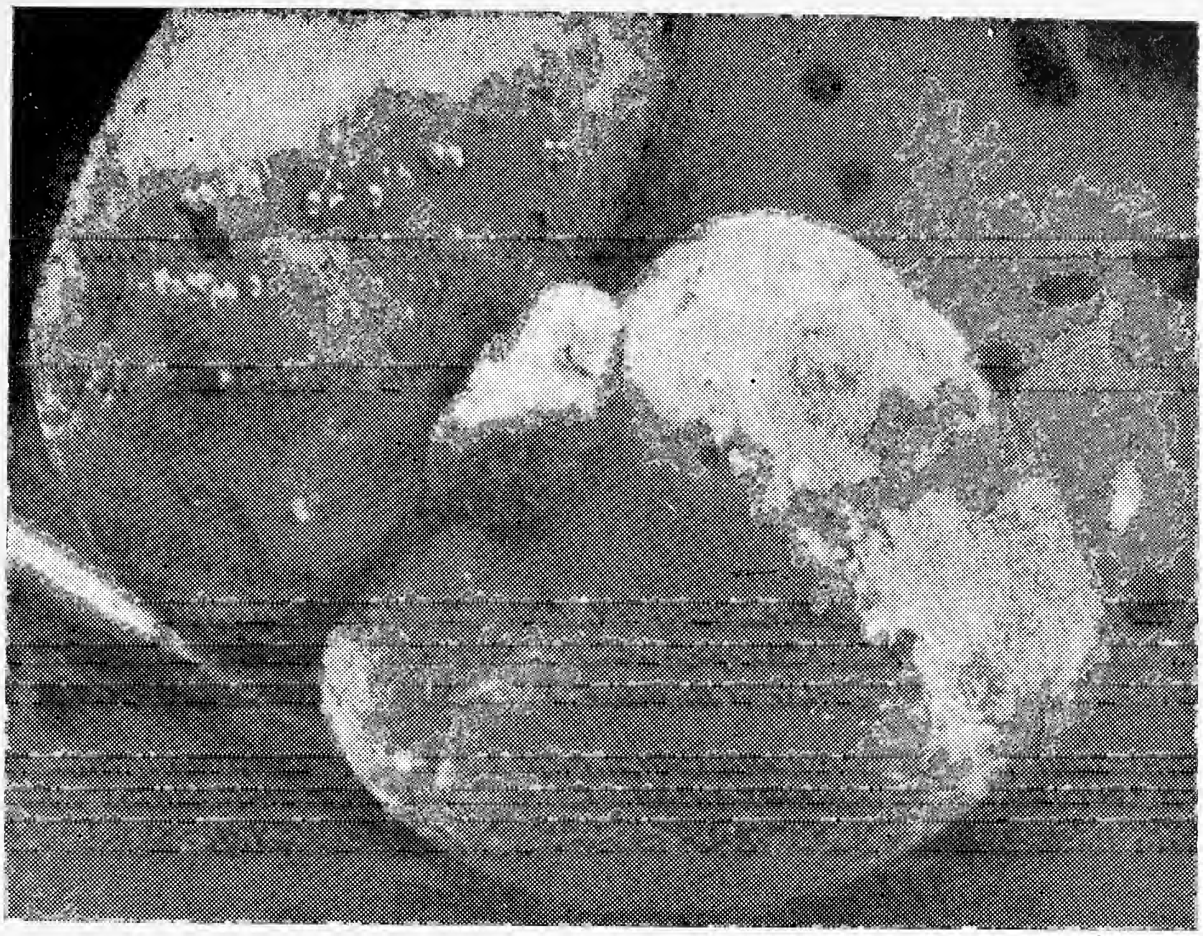

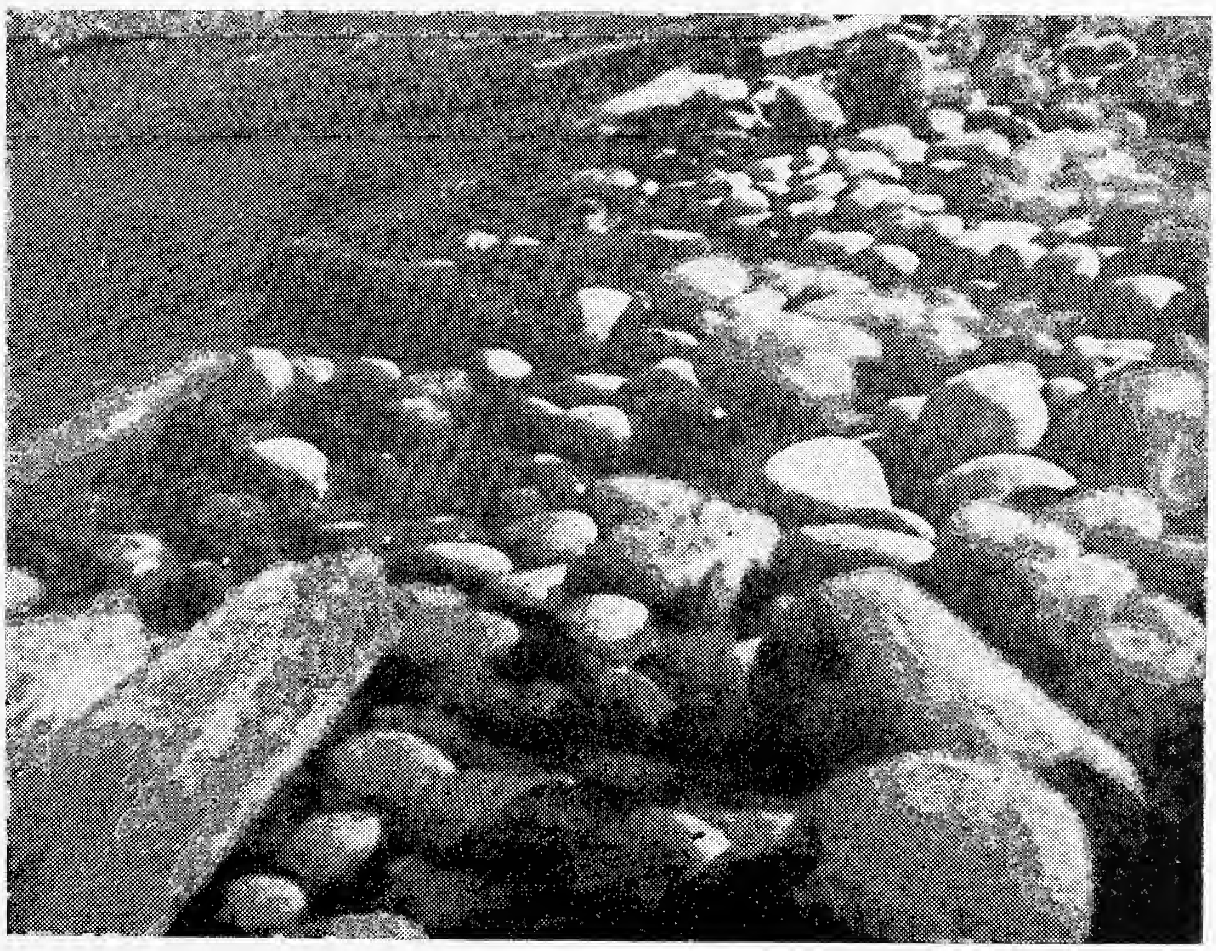

Above: Showing fish ova attached to stones.
Below: Showing destruction of ova in the breeding ground by timber logs.

The peak spawning period was observed in September-October and November. In these months the water velocity, temperature, and dissolved oxygen remain quite favourable for their breeding. They breed in shallow running semistagnant water along the banks of the rivers among gravel and stone. The eggs remain attached to stones in batches. The water temperature of the breeding ground ranged between 7.8 and 15.6°C, the atmospheric temperature was 12.9° to 31.2°C, pH of water was between 7.0 and 8.2 dissolved oxygen 9.0 to 18.1 ppm. The depth of breeding ground varied from 25 to 32 cm. The gradient was less and velocity was observed to be 0.496 metre/second.

2. **Tor tor** and **T. putitora:** These species spawn from April to July when the water of Alaknanda becomes turbid due to the melting of snow at the peaks. They move from the deeper waters or lower regions upward for breeding. This type of local movement was noticed right from April, when the water starts becoming turbid. It is believed that mature specimens travel upstream from Rishikesh or Hardwar, first to the upper reaches of the Ganga and then to Alaknanda and Bhagirathi for breeding. The eggs are laid on and under stones at a depth of 35 to 50 cm where the gradient is less. The water temperature of the breeding place was from 15° to 17.5°C, atmospheric temperature 26.1° and 31.2°C, pH of the water 7.0 to 8.2 and dissolved oxygen 9.0 to 9.9 ppm. The fertilized eggs were slightly brown in colour and found attached to the stones and rocks and other objects such as logs, etc. However, we could not get adult *Tor* species in Alaknanda after July-August when only large number of fry and fingerlings were found in the backwaters and sidestreams of the Alaknanda and Bhagirathi rivers. It appears that after spawning the adults move down the Ganga probably due to the effect of the low water temperature. Thus we could observe the breeding only from April to July.

3. **Labeo dyocheilus** and **L. dero:** These two species abound in Alaknanda, Bhagirathi and Pinder, etc. from March to June when they come from Ganga for the purpose of breeding. During these months, they are found with mature gonads. The eggs are laid on and among the stones towards the bank of the river at a depth of 30 to 35 cm in slow running water. The water temperature in the breeding grounds was 12.6° to 17.5°C, atmospheric temperature 26.8° (in April) to 31.2°C (in June), maximum pH was 8.2 and dissolved oxygen from 9.3 to 9.9 ppm. The velocity of water was 0.616 to 1.234 metre/sec. Thus, they prefer clear shallow water for breeding. The fertilized eggs were somewhat greenish in colour.

4. **Barilius bendelisis, B. vagra** and **B. barna:** These species always prefer small rivers and streams, where the water is clear and shallow with high percentage of dissolved oxygen. They do not survive in polluted water. In this investigation it was found that these species breed from April to June. The breeding grounds were observed in Nayar, Khoh and in the side stagnant waters of Alaknanda. These small fishes are found schooling in abundance and lay their eggs in shallow pockets of water under stones and weeds (algae), as well as in the sand mixed gravel bed at a depth of 15 to 28 cm. The water temperature of the breeding grounds ranged from 20.5° to 22.5°C with the pH from 7.0 to 7.3. The dissolved oxygen was 9.5 to 10.2 ppm. The water was semistagnant, with low velocity (0.197 to 0.204 metre/second) and less gradient.

5. **Puntius chilinoides** and **P. hexastichus:** The two species are very common in Nayar,

Mandakini and Pindar rivers and their breeding period was noticed to be from May to July and December to January. However, the actual breeding grounds of these species could not be located. But from the fry it was estimated that they breed in shallow water under stones and rocks, with the water temperature at 8.9°C, pH of water 7.0 and dissolved oxygen 16.8 ppm. The gradient and velocity of water was also low.

6. **Noemacheilus montanus, N. rupicola** and **N. multifasciatus:** These species spawn from July to August in small streams and rivulets. Being small in size, their breeding ground could not be located. But it is almost definite that they breed in small streams and rivulets and not in large snow-fed rivers like Alaknanda, Bhagirathi, etc.

7. **Glyptothorax pectinopterus:** This species breeds from April to August and is quite common in streams throughout the year. In Alaknanda, Bhagirathi and Pinder, etc. it occurs in abundance in the rainy season. Probably having been swept in from small streams and rivulets by the swift current. Its breeding niches could not be observed due to the increased water level and velocity (2.493 metres|second).

8. **Pseudecheneis sulcatus: P. sulcatus** is found in snow-fed streams all the year round. but in Alaknanda, Pindar, Bhagirathi and Jamuna it is available after April, when the water becomes turbid. Its spawning period was observed to be from April to August. The mature testes are branched. In female the abdomen is bulged out by large number of eggs. However, its breeding ground could not be located due to the high speed of water in the rainy season.

Destruction of eggs

During the course of this study it was found that the breeding grounds in Alaknanda and Nayar are disturbed by the floating of timber logs (Plate 1). In winter and summer the logging is most common in Alaknanda and Nayar. In this period most of the fishes are in spawning stage, for instance *Schizothorax* species breed from September to January and the *Puntius* species from December to January. The *Tor* and *Labeo* species breed from April to June-July. We have noticed that the logs that float in the main current of the river sometimes reach the banks of the river and strike the stones and rocks, and thus crush thousands of eggs and disturb the natural breeding grounds. It was estimated that about 26% eggs are damaged by this type of transportation of the timber. (Table 1).

Table 1

Destruction of fish eggs by timber in Alaknanda River

Spot No.	Nature of substratum	Total eggs examined	No. of living eggs	No. of damaged eggs	Percentage of damaged eggs.
1.	Stony	347	235	112	32.27
2.	Stony	286	160	126	44.05
3.	Stony & rocky	360	292	68	18.88
4.	Stony	198	178	20	10.10
5.	Stony	307	307	nil	nil
6.	Stony & Rocky	401	401	nil	nil

Discussion

According to this study most of the fishes of the Garhwal Himalaya breed in the summer and monsoon months. However, only *Puntius chilinoides* and *P. hexastichus* breed twice a year, i.e., from May to July and December to January. Of all the species included in this study, *Schizothorax* spp. have the longest

breeding period ranging from July to January. Their breeding is at peak during September to November, the colder days of the year, when the water has ample amount of dissolved oxygen (about 18.1 ppm). According to Jhingran (1975), *S. richardsonii* of Himachal Pradesh spawns from March to June. Bhatnagar (1964) in his studies on Bhakra reservoir fishes has reported that *Schizothorax plagiostomus* breeds in July-August and December-January. However, our observations are that the *Schizothorax* species of the Garhwal waters do not spawn intermittently. Probably one reason for the availability of the *Schizothorax* in the snow-fed rivers and the streams throughout the year is that the fish has a long and continuous breeding period. The other reasons are the favourable water spread and a large amount of dissolved oxygen.

Bhatnagar (1964) has reported that the *T. putitora* of the Bhakra reservoir first spawns in July and this activity continues intermittently throughout the year. According to Karamchandani *et al.* (1967), *T. tor* of Narbada river has a prolonged breeding season which commences in July-August and continues upto December with peak breeding from July to September. Some other studies on the breeding of the *Tor* species of the other regions are of Khan (1939), Qasim & Qayyum (1962), and Sehgal *et al.* (1971), and according to them *Tor* species spawn two to three or more times a year. But our studies show that the *Tor tor* and *T. putitora* of the Garhwal hills spawn once a year, i.e. from April to July. These species come to the Alaknanda and Bhagirathi from the Ganga for breeding. It appears that the presence of suitable isolated and well protected breeding grounds, the high amount of dissolved oxygen and the abundance of insect larvae in Bhagirathi and Alaknanda waters, which form the food of these species are some of the factors that attract *Tor* for this breeding migration.

Bhatnagar (1964) described the spawning of *Labeo dero* in July and according to him flooding was necessary for its breeding. However, our observations indicate that *L. dero* and *L. dyocheilus* of Garhwal rivers prefer shallow water for breeding. Similarly *Barilius bendelisis*, *Barilius barna* and *Barilius vagra* were also found to breed in shallow pockets of clear waters. According to Khanna (1958) and David *et al.* (1967), the presence of flood water in the breeding ground and a current of moderate intensity were essential for breeding and increased pH did not seem to be necessary for fish breeding. Mookerjee (1945) pointed out that change of pH may be one of the principal factors which may induce carp to spawn. Das & Das Gupta (1945) stated that although an increased pH and high oxygen content of water play an important role in the spawning of carps, they have no independent position. However, our observations indicate that high pH and flood water were necessary for the breeding of *Glyptothorax pectinopterus*, *Pseudecheneis sulcatus* and *Noemacheilus* species of this region. But high oxygen content, relatively low pH values and mild velocity of the water were essential for the breeding of *Schizothorax*, *Labeo*, *Puntius* and *Barilius* species of the Garhwal streams. On the basis of this study it may be pointed out that a suitable temperature is also necessary for the breeding of the different species.

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REPRODUCTION BIOLOGY OF THE SOFT-FURRED FIELD RAT, *RATTUS MELTADA PALLIDIOR* (RYLEY, 1914) IN THE RAJASTHAN DESERT[1]

B. D. Rana[2] and Ishwar Prakash[3]

(With three text-figures)

Introduction

The soft-furred field rat, *Rattus meltada* is distributed throughout India. It is found abundantly in the crop fields of the south-eastern region of the desert (Rana and Prakash 1980). It usually inhabits irrigated crop fields but is also found in grasslands on heavier soils. This species is one of the economically important among crop inhabitants and inflicts losses to standing crops and grain stores of cereals, chiefly wheat, jowar (*Sorghum vulgare*) and bajra (*Pennisetum typhoides*). Thus, keeping in view, its economic importance, an attempt has been made to study its ecological relationships in the desert environment (Rana 1981) and in this paper its reproduction biology is described.

The Study Area

Bisalpur (25°7′N, 73°10′E), is situated in western Rajasthan, on the south-eastern fringe of the Thar desert, very near to Aravalli ranges. The mean maximum and minimum temperatures are observed to the order of 32.8°C and 20.0°C respectively. The average amount of precipitation received is about 500 mm but 90 per cent falls during July-September period. The vegetation is rich due to the water retaining capacity of sandy loam. Rodents were trapped in a protected grassland and from surrounding crop fields. Two crops are raised in the region: rainfed, July to October and irrigated, November to March. Therefore, green food is available to rodents for the greater part of the year, except from April to June.

Material and Methods

The Soft-furred field rat, or the metad, *Rattus meltada pallidior* (Ryley, 1914) were collected every month at Bilaspur from January 1978 to December 1979. Soon after their collection, they were weighed, sexed and dissected. Ovaries were checked for the number of corpora lutea and uterine horns for implanted embryos in freshly killed material. The teats in females were also examined for any sign of lactation.

Epididymal smears were examined for the presence of sperms and uterine horns for an indication of embryonic mortality. The testes and ovaries were weighed to the nearest 0.001 g on a semi-micro Mettler balance.

Results

Male fecundity

Epididymal smear

Sexual maturity of male metads was attained at 45 g body weight during both the years

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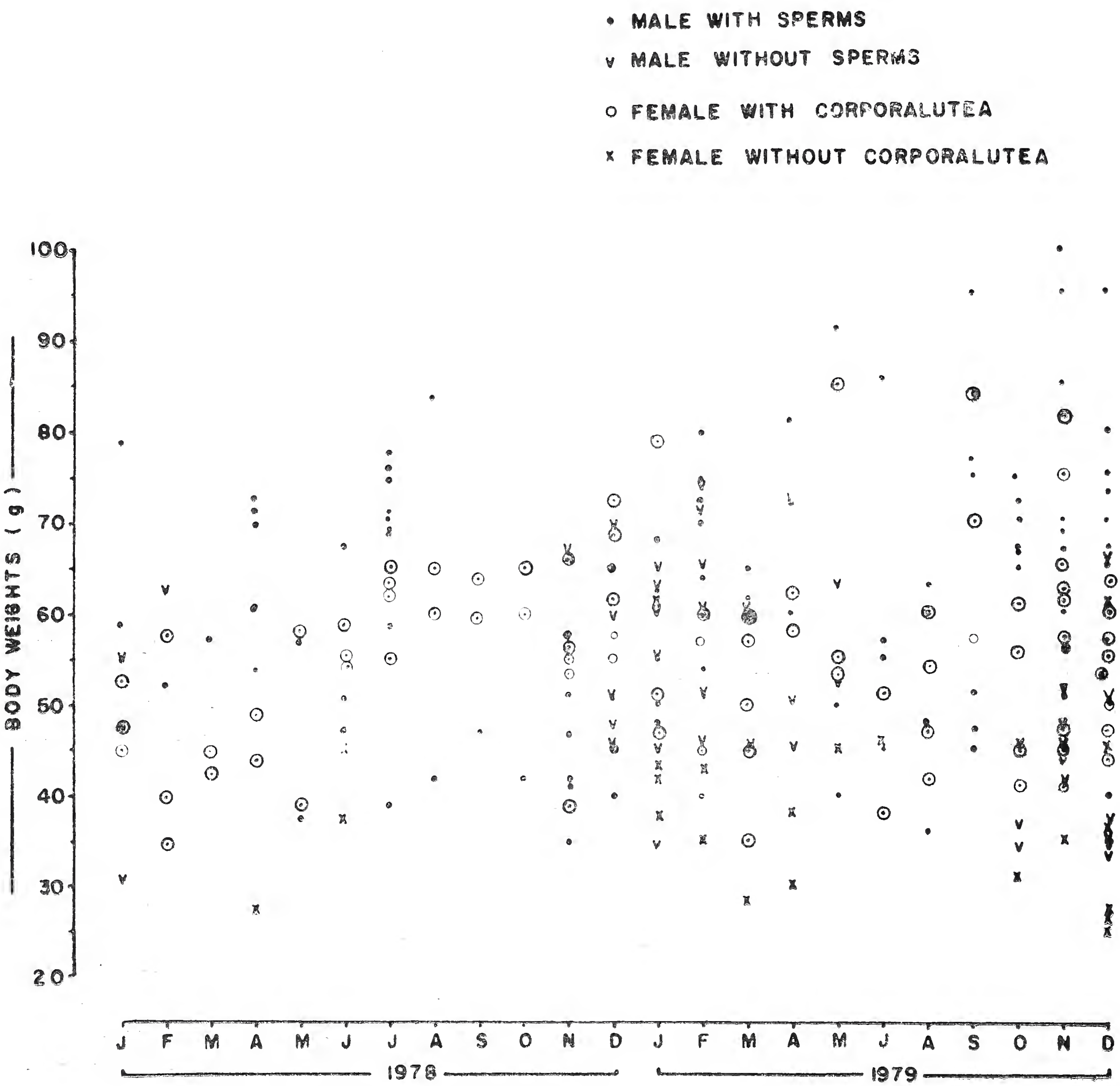

Fig. 1. Gross body weights of *R. m. pallidior* during 1978 and 1979.

of study (Fig. 1). However, a few metads weighing 70 to 73 g during 1978 and 1979 respectively did not exhibit sperms in their epididymis. It may possibly be due to regression of the testes. The regression of the testes during a part of the year has also been observed in many rodents (Asdell 1946). Prasad (1961) and Jain (1970) also found regressed testes in *T. i. cuvieri* and *T. i. indica* respectively. The present study points out that in male *R. m. pallidior* the reproductive activity does not cease completely during winter as pregnant

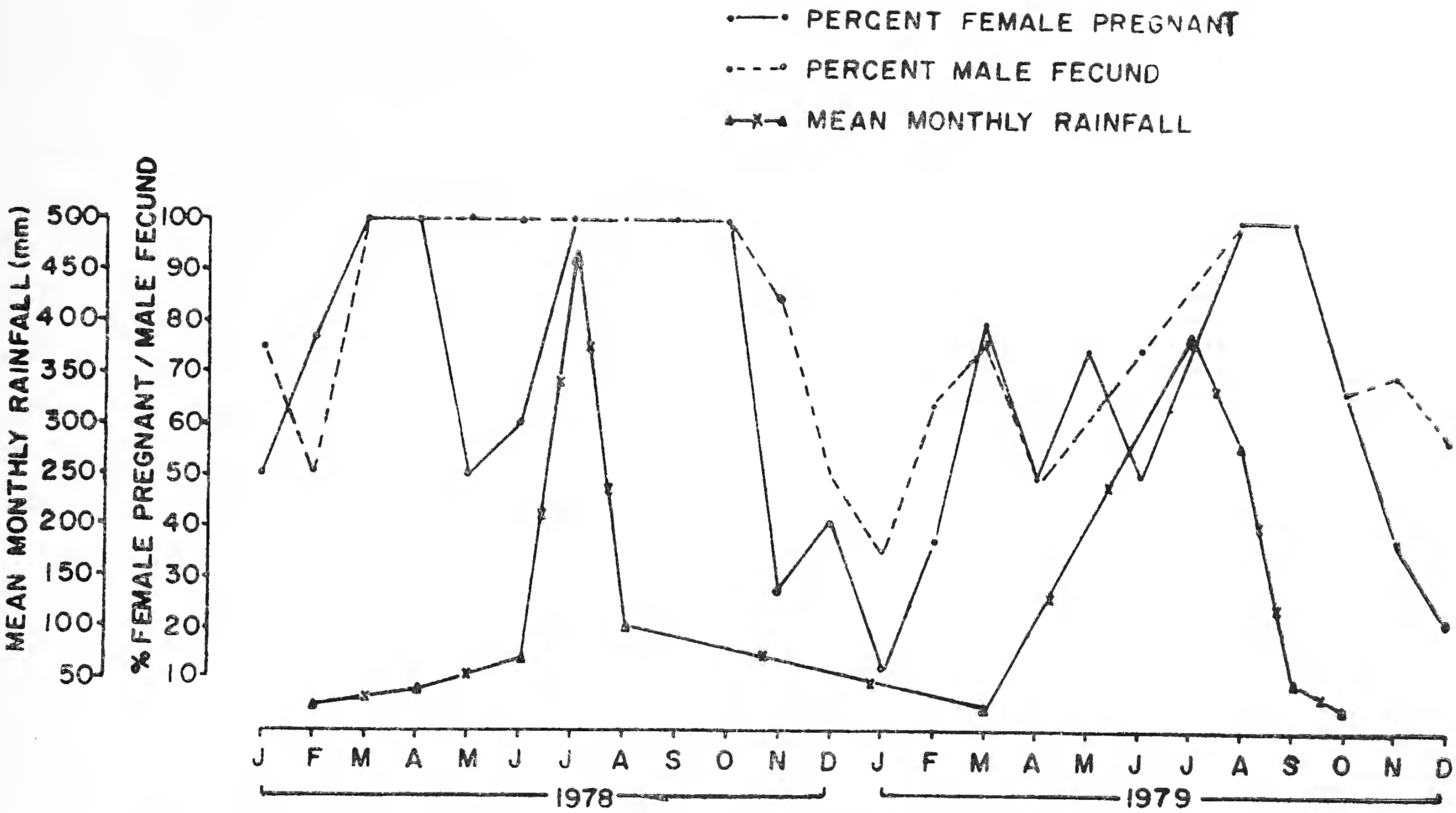

Fig. 2. The breeding intensity of *R. m. pallidior* in relation to the mean monthly rainfall.

Fig. 3. The male fecundity rate and mean paired testes weights of *R. m. pallidior*.

metads were found throughout the two years (Fig. 2).

The male metads were found to be fecund throughout the two years. But the maximum rate of fecundity (100 per cent) was observed from March to October, 1978. Thereafter, it reduced to 50 per cent in the month of December. Surprisingly, a minor peak in January was also observed. During 1979, two peaks of fecundity rate, one during spring and the second in monsoon seasons, were recorded.

A comparison of fecundity rate between the two years revealed that it remained at higher rate during 1978 (50 to 100 per cent) as compared to that of 1979 (35 to 100 per cent). The proportion of fecund males during both the years was also found to be closely similar to that of pregnancy rate in the population (Fig. 3).

Testes weights

Mean monthly weights of right and left testes did not differ significantly from each other in any of the months during the two years except during March 1978, when the right testes was found to be lighter than the left (Table 1). The weights of right and left testes were, therefore, pooled. The paired testes weight, differed significantly ($F = 13.38$, $P < 0.05$) between months. They were found to be maximum during June to October and lowest during December. During 1979, two peaks in paired testes weight, one during March and the other in the months of August to October was observed. However, the lowest testes weights were recorded during January (Fig. 3). The mean monthly paired testes weights run parallel to the per cent fecund males during both the years of the study.

FEMALE FERTILITY

Ovary weights

The mean paired ovary weights of adult metads exhibits two main peaks, one during March to May and the second during June to October period during 1978 (Table 2). Lowest weights were observed in December, soon after attaining their peak level in September, which may be due to ovarian refractoriness during winter. Similar trend in the variations of ovary weights was found in 1979 (Table 3).

TABLE 1

MONTHLY TESTES WEIGHTS (MEAN ± SE) OF *R. m. pallidior*

Months	Weight of testes (g) 1978 Right	1978 Left	1979 Right	1979 Left
Jan.	0.3225±0.10	0.3394±0.10	0.2402±0.04	0.2453±0.05
Feb.	0.3160±0.18	0.2925±0.14	0.4182±0.11	0.3695±0.35
Mar.	0.5210±0.00	0.6630±0.00	0.5520±0.04	0.5452±0.04
April	0.3306±0.05	0.3327±0.04	0.3623±0.08	0.3441±0.08
May	0.4320±0.23	0.4145±0.19	0.4036±0.22	0.4156±0.20
June	0.6700±0.19	0.6620±0.19	0.5135±0.06	0.4816±0.03
July	0.6543±0.06	0.6269±0.08	Collection was not made	
Aug.	0.8685±0.35	0.9050±0.30	0.5741±0.04	0.5754±0.01
Sept.	0.6590±0.00	0.5930±0.00	0.4574±0.25	0.6787±0.30
Oct.	0.3275±0.06	0.3050±0.04	0.8725±0.11	0.8212±0.08
Nov.	0.4710±0.08	0.4150±0.01	0.3914±0.05	0.3962±0.05
Dec.	0.2211±0.08	0.3129±0.09	0.4079±0.65	0.3826±0.59

TABLE 2

PREVALENCE OF PREGNANCY AND OVARY WEIGHTS OF *R. m. pallidior* DURING 1978

Months	Total number of females collected	Number of adult female metads			Prevalence of pregnancy	Paired ovary weights (Mean±SE)
		Not pregnant	Pregnant	Pregnant & lactating		
January	4	2	2	–	0.50	0.0135± .005
February	3	1	2	–	0.66	0.0150± .007
March	2	–	1	1	1.00	0.0220± —
April	2	–	2	–	1.00	0.0213± .006
May	2	1	1	–	0.50	0.0215±0.007
June	5	2	3	–	0.60	0.0310± .001
July	5	–	5	–	1.00	0.0452± .005
August	2	–	2	–	1.00	0.0441± .004
September	2	–	2	–	1.00	0.0463± .001
October	2	–	1	1	1.00	0.0267± .002
November	7	5	1	1	0.28	0.0172± .002
December	7	4	3	–	0.42	0.0101± .004

TABLE 3

PREVALENCE OF PREGNANCY AND OVARY WEIGHTS OF *R. m. pallidior* DURING 1979

Months	Total number of females collected	Number of adult female metads			Prevalence of pregnancy	Paired ovary weights (Mean±SE)
		Not pregnant	Pregnant	Pregnant & lactating		
January	8	7	1	–	0.12	0.0173± —
February	8	5	3	–	0.37	0.0273±0.002
March	10	2	7	1	0.80	0.0377±0.002
April	4	2	1	1	0.50	0.0229±0.002
May	4	1	3	–	0.75	0.0276±0.001
June	4	2	2	–	0.50	0.0176±0.001
August	4	–	4	–	1.00	0.0596±0.006
September	3	–	3	–	1.00	0.0663±0.005
October	6	2	3	1	0.66	0.0263±0.001
November	13	8	4	1	0.38	0.0221±0.001
December	24	19	5	–	0.20	0.0200±0.003

Production of ova

Sixty-eight pregnant females exhibited 282 corporalutea in right ovary and 238 in left ovary, which are significantly different ($x^2(_1) = 3.60$, $P < 0.05$) from each other, ova production being more in the right ovaries. During 1978, the right ovary (110) possessed significantly ($x^2(_1) = 7.40$, $P < 0.01$) larger num-

ber of corporalutea than the left (73, Table 4). However, during 1979, the difference was not significant (Rt. 172: Lt. 165, $x^2{}_{(1)} = 0.14$; Table 5).

The production of ova per pregnant female varied from 5.50 to 10.00 (av. 6.53) during 1978 and 5.00 to 12.00 (av. 8.25) during 1979. The average number of ova produced

TABLE 4

PRE-IMPLANTATION LOSSES IN *R. m. pallidior* DURING 1978

Mths.	Number of embryos			Number of corpora lutea				Pre-implanation losses			
	Right	Left	Total	Right	Left	Total	Mean±SE	Right	Left	Total	%
Jan.	5	3	8	6	5	11	5.50±0.50	1	2	3	27.2
Feb.	5	4	9	6	6	12	6.00±0.00	1	2	3	25.0
Mar.	7	6	13	8	7	15	7.50±0.50	1	1	2	13.3
Apr.	4	3	7	6	5	11	5.50±0.50	2	2	4	36.3
May	4	3	7	6	4	10	10.00±0.00	2	1	3	30.0
June	9	3	12	14	5	19	6.33±0.91	5	2	7	36.8
July	19	5	24	22	7	29	5.80±0.89	3	2	5	17.2
Aug.	7	5	12	9	5	14	7.00±0.79	2	–	2	14.2
Sept.	7	6	13	8	7	15	7.50±0.68	1	1	2	13.3
Oct.	5	6	11	6	9	15	7.50±0.50	1	3	4	26.6
Nov.	5	4	9	7	6	13	6.50±0.65	2	2	4	30.7
Dec.	10	6	16	12	7	19	6.33±0.82	2	1	3	15.7
Total	87	54	141	110	73	183	6.53±0.98	23	19	42	22.9

TABLE 5

PRE-IMPLANTATION LOSSES IN *R. m. pallidior* DURING 1979

Mths.	Number of embryos			Number of corpora lutea				Pre-implanation losses			
	Right	Left	Total	Right	Left	Total	Mean±SE	Right	Left	Total	%
Jan.	3	2	5	4	1	5	5.00±0.00	—	—	—	—
Feb.	10	9	19	14	13	27	9.00±0.00	5	5	10	37.0
Mar.	27	25	52	32	30	62	7.75±0.59	5	5	10	16.1
Apr.	7	6	13	10	7	17	8.50±0.28	3	1	4	23.1
May	9	12	21	13	12	25	6.05±0.00	6	3	9	36.0
June	9	8	17	13	11	24	12.00±0.00	4	3	7	29.0
Aug.	12	11	23	19	18	37	9.25±0.47	7	7	14	37.8
Sept.	10	9	19	15	13	28	9.33±0.45	5	4	9	32.2
Oct.	11	10	21	15	16	31	7.75±0.75	4	6	10	28.6
Nov.	12	13	25	17	18	35	7.00±0.70	5	5	10	28.6
Dec.	15	16	31	20	26	46	9.20±0.89	5	10	15	32.6
Total	125	121	246	172	165	337	8.25±2.35	49	49	98	29.08

TABLE 6

TRANSFER OF BLASTOCYST

Female nos.	Corpora lutea Right	Corpora lutea Left	Embryos present Right	Embryos present Left	Transfer of blastocyst
1	2	3	1	4	From right
14	4	3	3	4	— do —
15	4	5	3	6	— do —
24	4	1	3	2	— do —
50	2	6	3	5	From left to right

per pregnant female did not vary significantly between months and between seasons except during winter when it was significantly ($P < 0.01$) lower than that in the summer season during both the years (Tables 4 & 5). The high production rate of ova during summer months may be due to influence of day length which is maximum in this period in the desert region. The mean number of produced ova (8.2) during 1979 did not differ significantly ($x^2(_1) = 0.2416$) than that of 1978 (6.5).

Transfer of blastocyst

The transfer of blastocyst was investigated by comparing the number of corpora lutea and the actual number of embryos in both the uterine horns. Out of 68 pregnant females examined during both the years, in five cases the transfer of blastocyst was observed. In female nos. 1, 14, 15 and 24 the blastocyst was transferred from right to left, whereas, in female no. 50, it was transferred from left to right (Table 6). Transfer of blastocyst was also reported in Cutch Rock Rat, *Rattus cutchicus* (Prakash *et al.* 1973).

Implantation rate in right and left uterine horns

During 1978, the number of implanted embryos was significantly higher ($x^2(_1) = 7.72$, $P < 0.05$) in the right uterine horn. However, no significant difference ($x^2(_1) = 0.26$) was found between right (125) and left (121) implanted embryos during 1979. After pooling the embryo numbers for both the years of

TABLE 7

DISTRIBUTION OF LITTERS OF VARIOUS SIZES IN THE MONTHLY COLLECTION OF *R. m. pallidior* DURING 1978

Months	Frequency of occurrence of litters No. of implanted embryos 3	4	5	6	7	Total number of embryos	Mean±SE
Jan.	1	–	1	–	–	8	4.00±0.66
Feb.	–	1	1	–	–	9	4.50±0.64
March	–	–	–	1	1	13	6.50±0.61
April	1	1	–	–	–	7	3.50±0.01
May	–	–	–	–	1	7	7.00± —
June	1	1	1	–	–	12	4.00±0.42
July	–	3	1	–	1	24	4.80±0.69
Aug.	–	–	1	–	1	12	6.00±0.51
Sept.	–	–	–	1	1	13	6.50±0.58
Oct.	–	–	1	1	–	11	5.50±0.56
Nov.	–	1	1	–	–	9	4.50±0.61
Dec.	–	1	1	–	1	16	5.33±0.86
Total	3	8	8	3	6	141	5.03±0.89

Table 8

DISTRIBUTION OF LITTERS OF VARIOUS SIZES IN THE MONTHLY COLLECTION OF *R. m. pallidior* DURING 1979

Months	Frequency of occurrence of litters						Total number of embryos	Mean±SE
	Number of implanted embryos							
	4	5	6	7	8	9		
Jan.	–	1	–	–	–	–	5	5.00±0.00
Feb.	–	1	1	–	1	–	19	6.33±0.93
Mar.	1	1	2	2	1	1	52	6.50±0.56
Apr.	1	–	–	–	–	1	13	6.50±0.50
May	1	1	2	–	–	–	21	5.25±0.51
June	–	–	–	–	1	1	17	8.50±0.85
Aug.	1	–	2	1	–	–	23	5.75±0.62
Sept.	–	1	–	2	–	–	19	6.33±0.62
Oct.	–	3	1	–	–	–	21	5.25±0.39
Nov.	2	2	–	1	–	–	25	5.00±0.63
Dec.	1	1	–	2	1	–	31	6.20±0.73
Total	7	11	8	8	4	3	246	6.15±1.87

study, it is observed that the embryonic rate in right uterine horn is significantly ($x^2_{(1)} = 4.24$, $P < 0.05$) higher than that of left uterine horn (Tables 4 & 5).

Prevalence of pregnancy

Pregnant females were found during the two years of the study but the intensity of reproduction activity in the metad population was more during 1978 in which the pregnancy rate of 100 per cent was observed during 6 months, whereas, during 1979 it was only for two months. The period of maximum breeding activity (March-September, 1978) coinciding with the occurrence of larger litter size also. During 1979, however, 100 per cent pregnancies occurred during August-September, the period of maximum precipitation, but the largest litters occurred during February to June only. It is also observed that after a low pregnancy rate during winter, a peak occurs during spring, followed by a low during summer and then again with a peak during monsoon (Tables 2 & 3) — a typical reproduction cycle observed in other desert rodents also.

Litter size

Litter size varied from 3 to 7 (av. 5.03) and 4 to 9 (av. 6.15) during 1978 and 1979 respectively (Tables 7 & 8). The two yearly average was found to be 5.69 while in 1978 the larger litter size was scattered over the period March to September, they were restricted to the February-June period in 1979. Smallest litters were observed during the winter (November to January).

Super-foetation

One female *R. m. pallidior* bore four embryos in the left uterine horn, their mean crown rump length was 25 mm (new born young ones measure 34 mm in crown rump length). But the right uterine horn carried two embryos (crown rump length = 5 mm) which were quite healthy. Considerable difference in the size of embryos in the two uterine horns, suggests

that the second conception might have occurred around 9 to 12 days of first pregnancy (gestation period is 20 days, Bindra and Sagar, 1968). This phenomenon in metad is probably being reported for the first time though it is common in mice (Barnett and Munro 1970), in Indian gerbil, *T. i. indica* (Jain 1970) and in the shrew, *S. m. sindensis* (Rana and Prakash 1979).

Lactation

Out of all the pregnant females collected during both the years, during the period. March-April and October-November, seven female metads (10.3 per cent, Tables 2 & 3) were found to be pregnant as well as lactating. The difference between the first year (3 pregnant & lactating) and latter year (4 pregnant & lactating) did not vary significantly. The presence of pregnant and lactating females in the collection suggests the possibility of occurrence of postpartum oestrus in *R. m. pallidior* and therefore, a regular littering throughout the breeding season is logical. In various species of small mammals, the presence of postpartum oestrus has been reported earlier (Prakash *et al.* 1973, Asdell 1946, Barnett and Little 1968).

Embryonic Mortality

Pre-implantation loss

Pre-implantation losses were judged by comparing the number of corporalutea and the implanted embryos whereas, post-implantation losses were judged by identifying resorbed and mummified embryos in the uterus. In the sample of metads, the former type of mortality accounted for 22.9 and 29.0 per cent of the total number of ova produced during 1978 and 1979 respectively. The preimplantation mortality ranged from 13.3 per cent to 36.8 per cent during 1978 and 16.1 to 37.8 per cent in 1979 (Tables 4 & 5). The intensity of loss of ova during both the years was more in right (72) than in the left (68) uterine horn, the difference was, however, not statistically significant. Thus, the average annual pre-implantation mortality amounted to 26.92 per cent.

Post-implantation loss

One female (body weight, 54 g) bore four embryos, two in each uterine horn (their crown rump length was measured to 12-15 mm). Two in left horn were in healthy state but the two in right uterine horn were in mummified stage. Out of 387 total implanted embryos examined in this study, only 0.51 per cent account for post-implantation loss. In another case, a female during December possessed one embryo in right and three in left uterine horn. These four embryos were found to be resorbed, which amounts to 1.03 per cent loss. The total post-implantation loss comes to 1.55 per cent.

Annual Productivity

The number of young produced by an adult metad during the breeding season can be determined by dividing the number of days of breeding season by number of days of gestation period (Prakash and Taneja 1969). The period of gestation in *R. m. pallidior* is 20 days (Bindra and Sagar 1968), and applying the data from this study we find that (365/20 = 18.20) litters can be produced by a female in a breeding season. Correcting this figure by multiplying it by the average prevalence of pregnancy (18.20 x 0.51 = 9.28), the number of litters per adult female comes to 9.28. Multiplying this with 5.69, the average number of embryos per pregnant female during

the breeding season, it appears that (9.28 x 5.60 = 52.80) young ones can be produced by a female annually. If the pre-implantation (26.92 per cent) and post-implantation (1.55 per cent) losses are accounted for, the figure is corrected to 52.52 young per female per year.

Discussion

Rattus meltada is essentially a sub-mesic species, distributed all over the Indian plains but its subspecies, *R. m. pallidior* occurs in the arid and semi-arid zones of northern India (Prakash 1975). Its frequency of occurrence is poor in arid zones but it is found in fair numbers on the foothills and in desert areas which receive over 500 mm rainfall annually. Its breeding season appears to be similar to those rodents inhabiting tropical regions of the country and not that of the Saharo-Indian rodents which breed during winter as stated by Bodenheimer (1957). It breeds throughout the year with two peaks, one during spring and the other during monsoon and two lows, one during summer and the other in winter, the latter shows very low pregnancy rates as well as smallest litter size. Our study area at Bisalpur, on the foothills of the Aravalli ranges, does not experience severe climatic and vegetational fluctuations as the low rainfall areas do. The metads being nocturnal and fossorial are not exposed to severities of climatic conditions. Secondly in this area, due to the presence of irrigation cropping, green food is consumed by them for the greater part of the year. Experiencing these environmental conditions *R. m. pallidior* maintain rather a high prevalence of pregnancy rate with bimodal peaks, one in spring and the other in monsoon. It is surprising, however, that *R. meltada* inhabiting similar environmental conditions in Uttar Pradesh, Punjab and Pakistan breed from March to October only (Bindra and Sagar 1968, Guraya and Gupta 1975, Srivastava 1966, Smiet *et al.* 1980). In southern India, however, *R. m. meltada* breeds all the year round (Blanford 1888-91, Lloyd 1909, Chandrahas and Krishnaswami 1974). In Uttar Pradesh and Punjab the non-reproductive state of female metads and low breeding rate at our study area during winter may be due to the partial quiescent state of ovary. After this refractory period, their inherent physiologic activity is accelerated causing a spring peak in pregnancy rate in *R. m. pallidior.* The breeding activity slightly decreases during May and June, the hottest months of the year. Second main peak then occurs during the monsoon season. These two peaks well coincide with the availability of green food to *R. m. pallidior* which in turn influences their reproductive activity. *R. m. pallidior,* the northern subspecies of metad was even able to maintain a fairly high (50 to 80 per cent) prevalence of pregnancy during summer of 1978 and 1979 at the study site, when the air temperature was high and the relative humidity was low. The maintenance of a relatively high rate of reproduction during summer is presumably a reflection of the rodent's efficient eco-physiological adaptive mechanisms to cope with the arid environment.

The mean litter size of *R. m. pallidior* was 5.69 which is slightly lower than 6.0 reported by Bindra and Sagar (1968) at Ludhiana, but more or less equal to that of Kanpur metads (5.7, Srivastava 1966). However, the lowest litter size was reported by Lloyd (1909) in India as a whole.

A comparison of mean litter size and latitudes of the localities revealed that it was the lowest, 4.8 in Karnataka (latitude 12°), and the highest, 6.0 in Punjab (latitude 30°) and

a mid position was occupied (5.7) by Bisalpur field metads (latitude 25°). Thus, a relationship between litter size and latitude exists, which was larger in Northern than in Southern India, irrespective of wide variations in their geographical range.

Another very interesting point emerged out of this study is the occurrence of superfoetation which is not recorded in any other species of *R. meltada* in India.

Annual productivity of *R. m. pallidior* is comparatively higher, 52.52 young ones/year than other species of desert rodents such as *R. cutchicus* (19.96, Prakash *et al.* 1973). *T. i. indica* (17.75, Jain 1970); and more or less equal to *R. norvegicus* (53.4 young/adult female/year; Southwick 1966).

Acknowledgements

We are grateful to the Director, Dr. H. S. Mann for providing necessary facilities and constant encouragement throughout the course of this study, to Dr. P. K. Ghosh, Head of Division of Animal Studies for various useful suggestions. Thanks are also due to staff members of Cartography Section of the Institute for drawing. The assistance of Sarvashri R. P. Mathur, B. K. Soni and Mala Ram during field work are also acknowledged.

Summary

The Soft-furred field rat, *Rattus meltada pallidior* (Ryley) were snap trapped every month during 1978 and 1979 at Bisalpur (25°7′N, 73°10′E) situated on the fringe of the Thar desert in India. The male *R. m. pallidior* were found to be fecund in every month from January 1978 to December 1979. The fluctuations in testes weights coincided with the number of pregnant females. The left testes of adult rodents collected over two years were observed to be heavier than the right. The average testes weights were also found to vary significantly ($P < 0.05$) from month to month.

The production of ova ranged from 5.5 to 10.0 (av. 6.5) and 5 to 12 (av. 8.2) during 1978 and 1979 respectively. The maximum number of ova per pregnant female metad was produced during the period of maximum precipitation. The implanted embryos per pregnant female varied from 3 to 7 and 4 to 9 during 1978 and 1979, average being 5.03 and 6.15 respectively.

Embryonic mortality before implantation was found to be 22.9 and 29.0 per cent during 1978 and 1979 respectively and due to mummification and resorption 0.51 per cent and 1.03 per cent respectively.

Considering these losses, litter size and prevalence of pregnancy during both the years, the annual production was estimated to be 52.52 young ones per annum.

R. m. pallidior litters all through the year. The prevalence of pregnancy was found to be broadly correlated with the day length. Maximum production appears to have been influenced by the level of nutrition which was found to be maximum during monsoon due to availability of green forage in the desert.

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FLOWERING PLANTS AROUND THE HOLY SHRINE OF KEDARNATH, UTTAR PRADESH[1]

J. K. Semwal[2]

(With a text-figure)

This paper gives an account of the angiospermic flora of Kedarnath, which is an alpine zone in Garhwal Himalaya. A list of 262 species of flowering plants represented by 149 genera and 52 families is given from 3200 to 3800 metre altitude a.s.l. The dominant families of the area are: Ranunculaceae, Brassicaceae, Caryophyllaceae, Rosaceae, Apiaceae, Asteraceae, Ericaceae, Primulaceae, Scrophulariaceae, Lamiacea, Polygonaceae, Orchidaceae, Liliaceae and Poaceae.

Introduction

Garhwal Himalaya is famous for its vegetation and some of the noblest peaks of the world mountain system namely, Nanda Devi, Kamet, Trisul, Dunagiri, Chaukhamba, Nilkantha, Badrinath, Kedarnath and others. Kedarnath is the first among the Holy 'Panch (five) Kedars' of Uttarakhand, the other four being Madmaheshwar, Tungnath, Rudranath, and Kalpeshwar respectively. Mandakini river has its origin from Kedarnath glacier, and confluences with Alaknanda at Rudraprayag and Bhagirathi at Deoprayag whenceforth it is named 'Ganga'. The explored area lies in between 30° 40-45′ N and 79° 0-5′ E. The main rock components are of crystalline and metamorphic nature like other parts of the Himalayas (Fig. 1).

Compared with other sectors of the Himalayas, this region is humid. The characteristic feature of Kedarnath is the presence of marshy habitats, clothed with the typical marshy vegetation consisting of *Primula munroi, Juncus* spp. *Triglochin palustre,* sedges and species of *Epilobium* and others. *Callitrache verna* is a delicate aquatic herb floating on the water surface of ditches in these marshy localities.

In this region timberline zone is not conspicuous, as is observed in most of the alpine regions of Garhwal Himalaya, however, the distributional pattern of the common taxa is the same. The trees other than *Betula utilis* are present up to the elevation of 3200 m or slightly more according to the aspect of the slopes. The tree population is very scarce at the upper limits and gradually increases in density towards lower elevations. The major elements of temperate forests are *Aesculus indica, Lyonia ovalifolia, Fraxinus excelsior, Buxus wallichiana* and species of *Acer, Pyrus, Carpinus, Quercus* and *Rhododendron.* The tree species reaching the highest limit are *Betula utilis, Syringa emodi, Viburnum foetens, Prunus cornuta, Abies pindrow, Taxus baccata* and species of *Acer, Pyrus* and *Rhododendron* associated with the shrubs like the species of *Berberis, Spiraea, Rosa, Cotoneaster* and climbers like the species of *Clematis, Smilax* and occasionally *Codonopsis. Elaegnus umbellata* and *Pyrus lanata* can be seen here and there on road sides up to 3000 m along with *Piptanthus*

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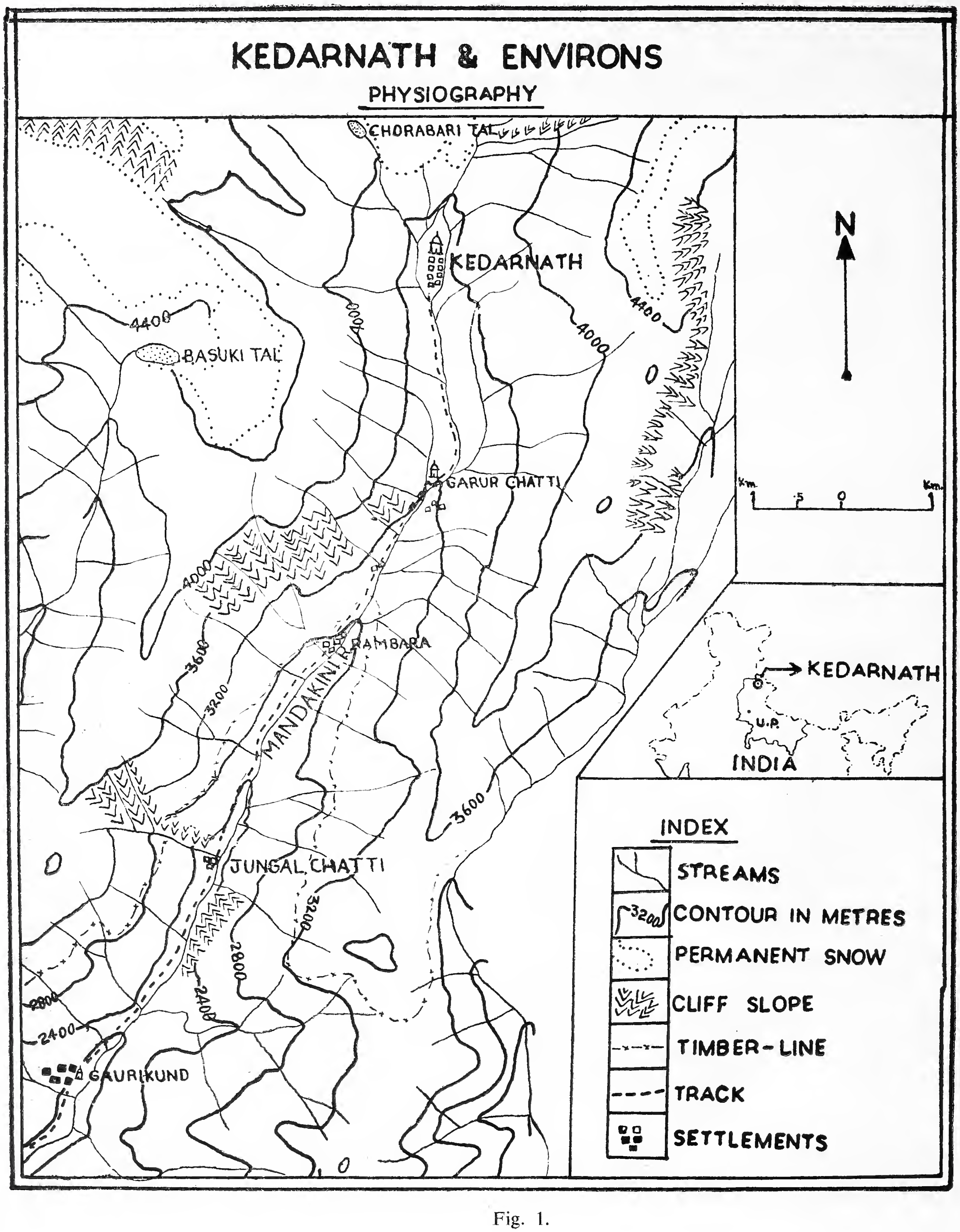
KEDARNATH & ENVIRONS
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CHORABARI TAL
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KEDARNATH
U.P.
INDIA
INDEX
STREAMS
CONTOUR IN METRES
PERMANENT SNOW
CLIFF SLOPE
TIMBER-LINE
TRACK
SETTLEMENTS

Fig. 1.

nepalensis, Cotoneaster affinis and some others. Unlike other alpine zones of the western Himalayas pure stands of the scrubs of *Rhododendron campanulatum* are lacking in this part.

The pattern of seasonal appearance of various plant species in this alpine zone is similar to that of Tungnath (Semwal *et al.*, 1981). The vegetation of the glacial bed is quite distinct compared to that of the meadows and marshy lands. The species found in these habitats are tufted and very much reduced in size forming the continuous interwoven matted cushions on the grounds. *Androsace villosa* and *Arenaria perlevis* are the typical examples of such vegetation, *Primula nivalis, P. minutissima* and *Helerpestes sermentosa* are found in rock crevices in these harsh habitats. The plant species on boulders and dry rocky faces are the species of *Sedum, Lychnis, Potentilla, Arcyosperma, Rheum, Senecio, Ligularia, Selinum, Goodyera* and many others. The vegetation of the ravines is constituted by the species of *Pedicularis, Epilobium, Impatiens, Polygonum* and *Rumex* etc. *Chamaenerion latifolium* and *Polygonum affine* are the most attractive species of the ravines. *Danthonia cuminsii* is the dominant alpine grass on steep slopes like in other alpine zones.

This alpine zone was previously explored by M. A. Rau during the last week of September 1958 (Rau 1961). He recorded about 53 species of flowering plants from Kedarnath. I have been working on the alpine flora of Tungnath (Semwal, 1981; Semwal *et al.*, 1981; Semwal and Gaur, 1981). During the course of these studies it was considered useful to explore the neighbouring alpine zones for comparison. Collections were made during early June 1978 and late July 1981. The specimens were compared with the authentic specimens of the 'Herbarium of Botanical Survey of India. Northern Circle Dehradun' (BSD) and are deposited in the herbarium of Garhwal University, Srinagar, U.P. Bentham and Hooker f.'s system is followed with slight modifications as proposed by Hutchinson (1973) in the arrangement of families.

The little known taxa recorded in the present work are, *Circaeaster agrestis, Gentiana albicalyx, Cypripedium elegans* and *Herminium pugioniforme*. *Circaeaster agrestis* was collected from an elevation of 3200 m and the other three were collected between 3500-3600 m altitudes.

ENUMERATION

DICOTYLEDONS

RANUNCULACEAE

Aconitum heterophyllum Wall. ex Royle

Herb with dull green purple veined flowers. July, 1981. Semwal 7210.

Anemone narcissifolia Linn. var **polyanthes** Finnet et Gagnep.

White flowered hairy herb on rocks. July, 1981. Semwal 7242.

A. obtusiloba D. Don

Herb in meadows with white and blue flowers. June, 1978. Semwal 7157.

A. rivularis Buch.-Ham.

Large herb with white flowers. July, 1981. Semwal 7167.

A. tetrasepala Royle

Herb with cream-white flowers. June, 1978. Semwal 7179.

Caltha palustris Linn.

Marshy herb with brilliant-yellow flowers. June, 1978. Semwal 7156.

Clematis barbellata Edgew.

Climbers, sometimes spreading on grounds in alpine slopes, flowers purplish. June, 1978. Semwal 7168.

Halerpestes sarmentosa (Adms) Kom. et Klob

Small glabrous herb with yellow flowers. July, 1981. Semwal 7221.

Oxygraphis polypetala (Royle) Hook. f. et Thoms.

Scapose glabrous herb with yellow flowers and persistent calyx. June, 1978. Semwal 7138.

Ranunculus diffusus DC.

Glabrascent herb with yellow flowers. June, 1978. Semwal 7162.

R. hirtellus Royle

Herb abundant in marshy meadows, flowers yellow. June 1978. Semwal 7159.

Thalictrum alpinum Linn.

Small glabrous herb with minute, drooping purple flowers. July, 1981. Semwal 7211.

T. minus Linn.

Erect herb with purplish flowers. July, 1981. Semwal, 7234.

Berberidaceae

Berberis edgeworthiana Schneid.

Tall shrub with yellow flowers, spines few. June 1978. Semwal 7169.

B. jaeschkeana Schneid.

Spinous shrub with yellow flowers. July, 1978. Semwal 7184.

Podophyllum hexandrum Royle

Herb with palmate leaf and drooping fruit, very rare. July, 1981. Semwal 7212.

Circaeasteraceae

Circaeaster agrestis Maxim.

A small glabrous herb growing in crevices, perianth very much reduced, rare. July, 1981. Semwal 7213.

Papaveraceae

Meconopsis aculeata Royle

Aculeate herb with sky-blue flowers, in ravines. July, 1981. Semwal 7217.

M. robusta Hook. f. et Thoms.

Robust herb with light yellow flowers, not common. July, 1981. Semwal 7171.

Fumariaceae

Corydalis cornuta Royle

Spreading yellow flowered herb. July 1981. Semwal 7165.

C. cashmeriana Royle

Small delicate herb with bulbous base and blue flowers. June, 1978. Semwal 7136.

C. govaniana Wall.

Tufted herb with yellow flowers. June 1978. Semwal 7147.

C. vaginans Royle

Glabrous herb with yellow flowers. July, 1981, Semwal 7215.

Brassicaceae

Arcyosperma primulifolium (Toms) O. E. Schulz

Lithophytic white flowered herb. June, 1978. Semwal 7141.

Barbarea vulgaris R. Br.

Erect herb with yellow flowers. June, 1978. Semwal 7158.

Draba gracillima Hook. f. et Thoms.

Weak herb with minute yellow flowers. June, 1978. Semwal 7142.

Lepidium ruderale Linn.

Glabrous herbs with fruits. July, 1981. Semwal 7208.

Megacarpaea polyandra Benth.

Large herb with dull white flowers. July 1981. Semwal 7371.

Sisymbrium wallichii Hook. f. et Thoms.

Herb with white flowers with long pods. July 1981. Semwal 7219.

Thlaspi andersonii (Hook. f. et Thoms.) O. E. Schulz

Herb with white flowers. June, 1978. Semwal 7148.

VIOLACEAE

Viola biflora Linn.
Small herb with yellow flowers. July, 1981. Semwal 7214.

V. serpens Wall.
Herb with violet flowers. June, 1978. Semwal 7170.

CARYOPHYLLACEAE

Arenaria perlevis (Williams) Handl.-Mazz.
Lithophytic white flowered herb. July, 1981. Semwal 7222.

Cerastium vulgatum Linn.
Herb with white flowers. June, 1978. Semwal 7127.

Gypsophila cerastioides D. Don
Herb with pink streaked flowers. July 1978. Semwal 7105.

Lychnis indica Benth.
Herb with fimbriate petals. June, 1978. Semwal 7172.

L. nutans Benth.
Pubescent herb with purplish flowers. July, 1981. Semwal 7254.

L. pilosa Edgew.
Herb on rocks with white flowers. July, 1981. Semwal 7246.

Sagina saginoides (Linn.) Karsten
Dark green glabrous white flowered prostrate herb. June, 1978. Semwal 7114.

Silene vulgaris (Moench) Garcke
Large glabrascent herb with greenish-white flowers. July, 1981. Semwal 7220.

Stellaria uliginosa Edgew. et Hook. f.
Apetalous spreading herb. July, 1981. Semwal 7185.

S. cherleriae (Fisch.) Williams
Cushioned herb with white flowers. July, 1981. Semwal 7223.

S. himalensis Majumdar
Glabrous herb with bright-white flowers. June, 1981. Semwal 7191.

S. patens D. Don
Diffused herb with white flowers. July, 1981. Semwal 7301.

HYPERICACEAE

Hypericum hookeriana Wt. et Arn.
Small shrub with large yellow flowers. July, 1981. Semwal 7312.

H. nepaulense Choisy
Herb with yellow flowers. July, 1981. Semwal 7224.

GERANIACEAE

Geranium collinum Stephan ex Willd.
Glabrous herb with dark pink flowers. July, 1981. Semwal 7227.

G. palustre Linn.
Large glabrascent herb with pink flowers. July, 1981. Semwal 7235.

G. wallichianum Sw.
Straggling herb with pink-purple flowers. July, 1981. Semwal 7236.

BALSAMINACEAE

Impatiens amplexicaulis Edgew.
Erect pink flowered herb. July, 1981. Semwal 7303.

I. glandulifera Edgew.
Tall herb in ravines with dark pink flowers. July, 1981. Semwal 7309.

I. thomsonii Hook. f.
Marsh herb with umbellate pale flowers. July, 1981. Semwal 7248.

RUTACEAE

Skimmia laureola Sieb. et Zucc.
Prostrate shrub, flowers greenish. June, 1978. Semwal 7186.

ACERACEAE

Acer acuminatum Wall. ex D. Don
Tree with white flowers and pink winged fruits. June, 1978. Semwal 7199.

A. caesium Wall. ex Brandis
Large tree, flowers white. June, 1978. Semwal 7188.

FABACEAE

Astragalus chlorostachys Lindl.
Erect herb with yellow flowers. July, 1981. Semwal 7225.

Lotus corniculatus Linn.
Decumbent herb with yellow or orange flowers. July, 1981. Semwal 7241.

Parochetus communis Buch.-Ham ex D. Don
Prostrate herb with blue flowers. July, 1981. Semwal 7187.

Piptanthus nepalensis D. Don
Pubescent shrub with yellow flowers. June, 1978. Semwal 7189.

Trifolium repens Linn.
Herb with white flowers in globose heads. June, 1978. Semwal 7174.

Trigonella pubescens Edgew. ex Baker
Diffused herb with yellow flowers. June, 1978. Semwal 7125.

ROSACEAE

Cotoneaster acuminatus Lindl.
Erect shrubs, flowers white. June, 1978. Semwal 7175.

C. rotundifolius Wall. ex Lindl.
Procumbent shrub with pinkish-white flowers. July, 1981. Semwal 7226.

Fragaria nubicola Lindl. ex Lacaita
Herb with white flowers. June, 1978. Semwal 7128.

F. daltoniana Gay
Stoloniferous herb with dark green leaves and white flowers. June, 1978. Semwal 7119.

Geum urbanum Linn.
Erect herb with yellow flowers. July, 1981. Semwal 7302.

G. elatum (Royle) Hook. f.
Leaves forming rosette, flowers large, yellow and drooping. July, 1981. Semwal 7255.

Potentilla cuneifolia Betrol.
Base shrubby, leaves glabrous, trifoliate, flowers yellow. July, 1981. Semwal 7228.

P. arbuscula D. Don
Shrubs on rocks with yellow flowers. July 1981. Semwal 7243.

P. argyrophylla Wall. ex Lehm.
Herb with silvery trifoliate leaves and yellow flowers. July, 1981. Semwal 7304.

P. atrosanguinea Lodd.
Herb with crimson-red flowers, abundant, June, 1978. Semwal 7159.

P. doubjouneana Camb.
Glabrascent herb on rocks with trifoliate leaves and yellow flowers. July, 1981. Semwal 7229.

P. fulgens Wall. ex Hook.
Silky herb with yellow flowers. June, 1978. Semwal 7176.

P. microphylla D. Don var. **commutata** Hook. f.
Herb, leaves green-glaucous above and pubescent beneath, flowers yellow. June 1978. Semwal 7149.

P. polyphylla Wall. ex Lehm.
Pubescent diffused herb with yellow corymbose flowers. July, 1981. Semwal 7262.

Rosa macrophylla Lindl.
Erect shrubs with large pink flowers. June, 1978. Semwal 7177.

R. sericea Lindl.
Shrub with white flowers. July, 1978. Semwal 7230.

Rubus nutans Wall.
Creeping shrubby herb with white flowers. June, 1978. Semwal 7178.

R. pedunculosus D. Don
Rambling shrubs with light pink flowers. June, 1978. Semwal 7183.

Sibbaldia cuneata Hornem. ex O. Ktze.
Creeping, base shrubby, flowers minute yellow. June, 1978. Semwal 7123.

S. micropetala (D. Don) Hand.-Mazz.
Diffused herbs with minute yellow flowers. July, 1981. Semwal 7315.

S. purpurea Royle
Similar to *S. cuneata* but with pentafoliate leaves and pink flowers. June, 1978. Semwal 7102.

Spiraea bella Sims.
Shrub with light pink flowers. July, 1981. Semwal 7263.

S. canescens D. Don
Shrub with white flowers. July, 1981. Semwal 7319.

S. vestita Wall. ex G. Don
Herbs, leaves pinnate, flowers greenish-white. July, 1981. Semwal 7249.

Saxifragaceae

Chrysosplenium tenellum Hook. f. et Thoms.
Delicate creeping glabrous herbs with small green-yellow flowers. June, 1978. Semwal 7132.

Parnassia nubicola Wall. ex Royle
Glabrous herb with single, sessile, cauline leaf, flowers solitary, terminal. July, 1981. Semwal 7207.

Saxifraga brachypoda Wall. var. **fimbriata** (Wall.) Engl. et Irmsch.
Tufted herbs with yellow flowers. July, 1981. Semwal 7247.

S. brunoniana Wall. ex Sternb.
Stoloniferous with solitary yellow flowers. July, 1981.

S. diversifolia Wall. ex DC.
Erect glabrous herbs with corymbose yellow flowers. July, 1981 Semwal 7305.

S. pallida Wall. ex DC.
Herb with white flowers. July, 1981. Semwal 7250.

Grossulariaceae

Ribes glaciale Wall.
Shrub with unisexual purplish flowers. June, 1978. Semwal 7117.

Crassulaceae

Sedum bupleuroides Wall. ex Hook. f. et Thoms.
Fleshy herbs with purplish-red flowers. July, 1981. Semwal 7203.

S. heterodontum Hook. f. et Thoms.
Fleshy herbs with greenish or yellowish flowers. June, 1981. Semwal 7118.

S. imbricatum (Edgew.) Walp.
Herb on rocks with dull yellow flowers. July, 1981. Semwal 7232.

S. quadrifidum Pall.
Densely tufted herbs with small red flowers. July, 1981. Semwal 7206.

S. trullipetalum Hook. f. et Thoms.
Herbs on boulders with yellow flowers. July, 1981. Semwal 7233.

Callitrichaceae

Callitriche verna Linn.
Delicate aquatic herbs floating on water surface. July, 1981. Semwal 7306.

Onagraceae

Chamaenerion latifolium (Linn.) Sw.
Herbs with beautiful purple-pink flowers in glacial beds. July, 1981. Semwal 7238.

Epilobium laxum Royle

Erect glabrous herbs in marshy localities. July, 1981. Semwal 7307.

E. palustra Linn.

Herbs with pinkish-white flowers. July, 1981. Semwal 7317.

E. royleanum Hausskn.

Herbs with pink flowers. June, 1981. Semwal 7180.

Apiaceae

Acronema tenera Edgew.

Small herb in crevices with minute purplish flowers. July, 1981. Semwal 7239.

Bupleurum longicaule Wall. ex DC.

Glabrous procumbent herb with brownish-black flowers. July, 1981. Semwal 7308.

Heracleum brunonis (DC.) C. B. Clarke

Erect herb on rocky slopes with white flowers. July, 1981. Semwal 7318.

Selinum candollei DC.

Robust aromatic herbs with white umbels. July, 1981. Semwal 7279.

S. vaginatum C. B. Clarke

Herb in marshy places with dark-green glossy leaves and white flowers July, 1981. Semwal 7310.

Trachydium roylei Lindl.

Herb in the meadows with white flowers and black tipped fruits. July, 1981. Semwal 7369.

Vicatia coniifolia DC.

Glabrous herb with fruits. June, 1978. Semwal 7152.

V. millefolia (Klotzsch) C. B. Clarke

Herb with small flowered umbels. June, 1978. Semwal 7164.

Caprifoliaceae

Lonicera asperifolia (Decne) Hook. f. et Thoms.

Shrub with yellow flowers. June, 1978. Semwal 7130.

L. myrtillus Hook. f. et Thoms. var **depressa** Rehder

Decumbent shrub with white flowers. June 1978. Semwal 7121.

L. obovata Royle ex Hook. f. et Thoms.

Shrub with white corolla gibbous at the base. June, 1978. Semwal 7116.

Viburnum foetens Decne

Small tree with white flowers and red drupes. June, 1978. Semwal 7181.

Rubiaceae

Galium acutum Edgew.

Spreading herb with minute greenish-white flowers. July, 1981. Semwal 7240.

G. asperuloides Edgew.

Decumbent herbs with dull white flowers. July, 1981. Semwal 7244.

G. mollugo Linn.

Scabrous herbs with whitish flowers. July, 1981. Semwal 7311.

G. rotundifolium Linn.

Decumbent herbs, leaves in whorls of four, flowers white. June, 1978. Semwal 7182.

Valerianaceae

Valeriana hardwickii Wall.

Herb with white flowers. July, 1981. Semwal 7197.

Dipsacaceae

Morina longifolia Wall. ex DC.

Spinous herbs with pink flowers. July, 1981. Semwal 7245.

Asteraceae

Anaphalis cuneifolia Hook. f.

Herbs with cuneate leaves and white flowers. June, 1978. Semwal 7190.

A. nepalensis (Spreng.) Handl-Mazz.

Woolly herbs with lanceolate leaves and white heads. July, 1981. Semwal 7341.

A. royleana DC.
Woolly herbs with dirty white heads. June, 1978. Semwal 7196.

Artemisia roxburghiana Besser var. **grata** Hook. f.
Erect herbs, leaves green above and white beneath. July, 1981. Semwal 7348.

Aster peduncularis Wall.
Herbs with violet flowers. July, 1981. Semwal 7358.

Cicerbita cyanea (D. Don) Beauv.
Lithophytic herbs with blue flowers. July, 1978. Semwal 7355.

C. macrorhiza (Royle) Beauv.
Lithophyte, flowers purple-blue. July, 1981. Semwal 7350.

Dubyaea hispida (D. Don) DC.
Hispid herb with yellow heads. July, 1981. Semwal 7352.

Erigeron multiradiatus (DC.) Benth. et Hook. f.
Erect herbs with violet heads. July, 1981. Semwal 7363.

Gerbera lanuginosa Benth. var. **pusilla** Hook. f.
Small herb with solitary white heads. June, 1978. Semwal 7153.

Leontopodium himalayanum DC.
Woolly herbs with dull white heads. July, 1981. Semwal 7346.

Ligularia amplexicaulis DC.
Robust herbs with large glaucous leaves and yellow corymbose heads. July, 1981. Semwal 7354.

L. sibirica Cass. var. **racemosa** (DC.) Kitamura
Herbs with yellow racemose heads. July, 1981. Semwal 7366.

Myriactis javanica (Bl.) DC.
Erect herbs with purple heads. June 1978. Semwal 7175.

Saussurea hypoleuca Spreng.
Herb with drooping solitary heads. July, 1981. Semwal 7367.

S. lappa (Decne) Sch.-Bip.
Erect herb with purplish heads. July, 1981, Semwal 7356.

S. leontodontoides (DC.) Lipsch.
Herbs with sessile, purple heads. July, 1981. Semwal 7365.

S. obvallata (DC.) Sch.-Bip.
Robust aromatic herb with large translus-cent floral leaves. July, 1981. Semwal 7360.

S. piptathera Edgew.
Erect herb with simple leaves and purplish-violet heads. July, 1981. Semwal 7364.

S. taraxacifolia Wall. ex DC.
Aromatic herbs, acaulescent or almost so, heads purple. July, 1981. Semwal 7359.

Senecio chrysanthemoides DC.
Erect herbs with yellow corymbose heads, July, 1981. Semwal 7320.

S. kunthianus Wall. ex DC.
Aromatic herbs, leaves white tomentose below, heads yellow, corymbose. July, 1981. Semwal 7314.

Taraxacum officinale Weber
Glabrous scapose herb with solitary yellow heads. July, 1981. Semwal 7313.

CAMPANULACEAE

Campanula cashmeriana Royle
Herb with blue flowers. June, 1981 Semwal 7139.

Codonopsis rotundifolia Benth.
Climber with purple veined flowers. July, 1981. Semwal 7370.

Cyananthus lobatus Wall. ex Benth.
Glabrous herb with black calyx and dark blue flowers. July, 1981. Semwal 7368.

ERICACEAE

Cassiope fastigiata D. Don
Stem tufted, flowers drooping, white. June, 1978. Semwal 7139.

Gaultheria nummularioides D. Don
Decumbent shrubs, leaves with brown hairs on ventral surface, flowers light pink. June, 1978. Semwal 7161.

G. trichophylla Royle
Glabrous wiry herb with light pink flowers and sky blue fruits. July, 1981. Semwal 7135.

Rhododendron anthopogon D. Don
Creeping shrub with light yellow flowers. June, 1978. Semwal 7160.

R. arboreum Sm.
Small tree with large, red flowers. June, 1978. Semwal 7193.

R. campanulatum D. Don
Large shrubs with pale-purple flowers. June, 1978. Semwal 7198.

R. lepidotum Wall. ex G. Don
Small shrub with purplish-red flowers. July, 1981. Semwal 7199.

PRIMULACEAE

Androsace lanuginosa Wall. ex Roxb.
Spreading herb with lilac flowers. July, 1981. Semwal 7316.

A. villosa Linn.
Herb in glacial beds, forming dense cushions, flowers purple-lilac. July, 1981. Semwal 7264.

Lysimachia prolifera Klatt.
Prostrate herb with pale-purple flowers. July, 1981. Semwal 7259.

Primula denticulata Sm.
Scapose herb with pink-purple to pale-lilac flowers. June, 1978. Semwal 7133.

P. minutissima Jacq. ex Duby
Small herb in crevices with blue, solitary flowers. June, 1978. Semwal 7106.

P. munroi Lindl.
Marsh herb with white flowers. June, 1978. Semwal 7155.

P. nivalis Pall. var. **moorcroftiana** (Wall.) Pax.
Densely mealy herb with floral buds. June, 1978. Semwal 7104.

P. reidii Duthie
Hairy herb with cream-white flowers, on rocks. July, 1981. Semwal 7254.

OLEACEAE

Syringa emodi Wall. ex Royle
Small tree with fragrant white flowers. July, 1981. Semwal 7272.

GENTIANACEAE

Gentiana albicalyx Burkill
Small, stemless herb with imbricate leaves and white flowers. June, 1978. Semwal 7101.

G. argentea Royle ex D. Don
Herb with blue flowers, abundant in meadows. June, 1978. Semwal 7111.

G. capitata Buch.-Ham. ex D. Don
Glabrous herb with light blue flowers. June, 1978. Semwal 7107.

Swertia ciliata (G. Don) B. L. Burtt
Erect herb with purple flowers. July, 1981. Semwal 7260.

S. cuneata D. Don
Herb with blue flowers. July, 1981. Semwal 7281.

S. speciosa D. Don.
Robust glabrous herb with purple streaked, lurid-green flowers. July, 1981. Semwal 7324.

POLEMONIACEAE

Polemonium coeruleum Linn.
Herb, flowers blue. June, 1978. Semwal 7122.

BORAGINACEAE

Hackelia uncinata (Benth.) C. E. C. Fischer
Herb with blue flowers, yellow at the centre. July, 1981. Semwal 7261.

Lindelofia longiflora (Benth.) Baill.
Herb with intense blue drooping flowers. July, 1981. Semwal 7325.

Myosotis sylvatica Hoffm.
Hirsute herb with light blue flowers. July, 1981. Semwal 7201.

Onosma emodi Wall.
Hispid herbs on rocks with pink tipped flowers. July, 1981. Semwal 7251.

Trigonotis rotundifolia (DC.) C. B. Clarke
Abundant in meadows. Herb with blue flowers. July, 1981. Semwal 7109 and 7202.

Scrophulariaceae

Euphrasia platyphylla Pennell
Small herbs with white flowers in terminal spikes. July, 1981. Semwal 7252.

Hemiphragma heterophyllum Wall.
Spreading herb with dimorphic leaves, pink flowers and red fruits. July, 1981. Semwal 7266.

Pedicularis hoffmeisteri Klotzsch
Glabrous herb with yellow flowers. July, 1981. Semwal 7253.

P. pectinata Wall. ex Benth.
Erect herb with purple flowers. July, 1981. Semwal 7327.

P. punctata Decne
Ravine herb with purple-red flowers. July, 1981, Semwal 7322.

P. rhinanthoides Schr. ssp. **labellata** (Jacq.) Prain
In meadows. Herb with purple flowers. July, 1981. Semwal 7323.

Picrorhiza kurroa Royle ex Benth.
Glabrous prostrate herb with bluish flowers and bladdery seeds. June, 1978. Semwal 7108.

Scrophularia calycina Benth.
Robust herb with green flowers. June, 1978. Semwal 7115.

S. himalayensis Royle ex Benth.
Glandular herbs with greenish flowers. July, 1981. Semwal 7257.

Veronica cana Wall.
Erect herbs, flowers violet in terminal racemes. July, 1981. Semwal 7291.

V. macrostemon Bunge ex Ledeb.
Herb, flowers white in terminal clusters. July, 1981. Semwal 7321.

Lamiaceae

Clinopodium umbrosum (M. Bieb.) Koch
Erect herbs with purple flowers. July, 1981. Semwal 7296.

Nepeta nervosa Royle ex Benth.
Herbs with blue flowers. July, 1981. Semwal 7265.

N. govaniana Benth.
Aromatic herbs with yellow flowers. July. 1981. Semwal 7278.

Phlomis bracteosa Royle ex Benth.
Robust herbs with purple flowers. July. 1981. Semwal 7299.

P. macrophylla Wall.
Hirsute herbs with purple flowers. July, 1981. Semwal 7298.

Prunella vulgaris Linn.
Herbs with dimorphic purple flowers. July 1981. Semwal 7256.

Salvia hians Royle ex Hook.
Viscid herbs, flowers blue. July, 1981. Semwal 7292.

Stachys sericea Wall.
Aromatic herbs with pale-purple flowers. July, 1981. Semwal 7300.

Plantaginaceae

Plantago himalaica Pilger
Scapose glabrous herbs with green flowers. June, 1978. Semwal 7151.

Polygonaceae

Oxyria digyna Hill
Glabrous herbs in ravines, flowers pink or greenish. July, 1981. Semwal 7267.

Polygonum affine D. Don

Tufted herbs with creeping woody rootstock and red and pink flowers. July, 1981. Semwal 7326.

P. alpinum All.

Robust erect herbs with panicled white flowers. July 1981, Semwal 7338.

P. amplexicaule D. Don

Spreading herbs with crimson-red flowers. July, 1981. Semwal 7297.

P. delicatulum Meissn.

Glabrous annual herbs, flowers pale-white. July, 1981. Semwal 7287.

P. filicaule Wall. ex Meissn.

Strigose annual herbs with pink and white flowers. July, 1981. Semwal 7347.

P. glaciale Hook. f.

Annual herbs, flowers green and pink. July, 1981. Semwal 7344.

P. macrophyllum D. Don

Scapose herbs with red flowers in dense spikes, abundant in the marshy meadows. July, 1981. Semwal 7284.

P. rumicifolium Royle ex Bab.

Herb with purple and green flowers. July, 1981. Semwal 7293.

P. sinuatum Royle

Creeping herbs, flowers pink in solitary globose heads. July, 1981. Semwal 7289.

P. vaccinifolium Wall. ex Meissn.

Shrubs with pink flowers on rocks. July, 1981. Semwal 7343.

P. viviparum Linn.

Herb with bulbils, flowers light pink in spikes. July, 1981. Semwal 7329.

Rheum moorcroftianum Royle

On rocky slopes. Herb with large leaves, pink flowers and trigonous fruits. July, 1981. Semwal 7342.

R. emodi Wall. ex Meissn.

On rocks. Robust herbs with panicled white flowers and winged fruits. July, 1981. Semwal 7283.

Rumex acetosa Linn.

Glabrous herbs with pink-purple flowers. June, 1978. Semwal 7143.

R. nepalensis Spreng.

Erect herbs with greenish flowers. July, 1981. Semwal 7269.

EUPHORBIACEAE

Euphorbia pilosa Linn.

Erect herbs with yellow or dull purplish involucral leaves around the cyathia. July, 1981. Semwal 7328.

E. stracheyi Boiss.

Herbs with tuberous roots and green cyathia. July, 1981. Semwal 7150.

URTICACEAE

Parietaria debilis Forst.

Annual diffused herbs, flowers minute, greenish. July, 1981. Semwal 7277.

Pilea wightii Weddel var. **roylei** Hook. f.

Small herbs, flowers pink in terminal cymose clusters. July.

BETULACEAE

Betula utilis D. Don

Deciduous tree with greenish spikes. July, 1981. Semwal 7330.

FAGACEAE

Quercus semecarpifolia Sm.

Large trees with green nuts. July, 1981. Semwal 7268.

SALICACEAE

Salix elegans Reichb.

Deciduous shrubs with catkins. June, 1978. Semwal 7163.

S. fruticulosa Anderss.
Shrubs, catkins with seeds embedded in white wool. June, 1978. Semwal 7131 and 7144.
S. karelinii Turez ex Stschez
Decumbent shrubs, catkins brownish-purple. June, 1978. Semwal 7146.
S. lindleyana Wall. ex Anderss.
Prostrate shrubs with yellow catkins. June, 1978. Semwal 7145.

MONOCOTYLEDONS

Orchidaceae

Cypripedium elegans Reichb. f.
Herb with a pair of leaves and nodding solitary purple flower. June, 1978. Semwal 7166.
Goodyera fusca Hook. f.
Herbs, leaves mottled white, flowers white in spikes. June, 1978. Semwal 7173.
Herminium lanceum (Thunb.) Vuijk
Small herbs with pale yellow spikes. In-meadows. July, 1981. Semwal 7220.
H. monorchis (Linn.) R. Br.
Herb with green flowers. July, 1981. Semwal 7218.
H. pugioniforme Lindl. ex Hook. f.
Herbs with minute greenish flowers. July, 1981. Semwal 7216.
Malaxis muscifera (Lindl.) O. Ktze
On rocks. Herbs with yellowish flowers in dense spikes. July, 1981. Semwal 7280.
M. acuminata D. Don
Beautiful herb with purple flowers. July, 1981. Semwal 7209.
Orchis chusua D. Don
Herb with purple flowers, very rare. July, 1981. Semwal 7331.
O. latifolia Linn.
Erect herb with palmate tubers and pink flowers, rare. June, 1978. Semwal 7124.

Scitaminaceae

Roscoea alpina Royle
Herb on rocks with purple-violet flowers. July, 1981. Semwal 7334.

Haemodoraceae

Aletris pauciflora (Klotzsch) Hand.-Mazz.
Small herbs with white flowers. July, 1981. Semwal 7296.

Iridaceae

Iris kumaonensis Wall. ex G. Don
Attractive herbs with bright blue flowers. June, 1978. Semwal 7129.

Liliaceae

Clintonia udensis Trautv. var. **alpina** (Kunth ex Baker) Hara
Herbs with naked scapes and white flowers in terminal umbellate corymbs. July, 1981. Semwal 7276.
Fritillaria roylei Hook.
Herb with solitary terminal nodding greenish or pale-purple flowers. June, 1978. Semwal 7137.
Gagea lutea Schultz. f.
Herb with yellow flowers. June, 1978 Semwal 7140.
Nomocharis oxypetala (Royle) Balf. f. ex W.E. Evans
Herb with nodding yellow flowers. July, 1981. Semwal 7271.
N. nana (Klotzsch) E. H. Wilson
Herbs with purple-blue flowers. July. 1981. Semwal 7273.
Polygonatum multiflorum All.
Herb with alternate leaves and white flowers. July, 1981. Semwal 7295.

P. verticillatum All.
Herb with whorled leaves and white flowers. July, 1981. Semwal 7288.

Smilacina purpurea Wall.
Herb with purple flowers. July 1981. Semwal 7275.

Smilax vaginata Decne
Climber with small purplish flowers. July, 1981. Semwal 7335.

Trillium govanianum Wall. ex Royle
Herb with dark purple flowers. June, 1978. Semwal 7134.

JUNCACEAE

Juncus himalensis klotzsch et Garcke
On rocks. Herb with dark brown flowers. July, 1981. Semwal 7353.

J. membranaceous Royle ex D. Don
Herbs, flowers white in terminal heads. July, 1981. Semwal 7336.

Luzula multiflora (Retz.) Lej
Herbs with brownish-grey flowers. July, 1981. Semwal 7285.

JUNCAGINACEAE

Triglochin palustre Linn.
Marsh herb with pale-green flowers. July, 1981. Semwal 7214.

ARACEAE

Arisaema jacquemontii Blume
Herbs, spathe green. July, 1981, Semwal 7282.

A. wallichianum Hook. f.
Herbs, spathe purple. July, 1981. Semwal 7286.

CYPERACEAE

Carex nivalis Boott
Sedges, dark brown inflorescence. July, 1981. Semwal 7205.

Kobresia nitens C. B. Clarke
Sedges, spikes green. July, 1981. Semwal 7332.

POACEAE

Agrostis canina Linn.
Erect grass on rocky slopes, spikelets purplish. July, 1981. Semwal 7349.

A. munroana Aitch. et Hemsl.
Grass in meadows and rocky slopes. July, 1981. Semwal 7362.

A. pilosula Trin.
Grass with purple spikelets. July, 1981, Semwal 7339.

Calamogrostis emodensis Griseb.
Grass in rocky slopes. July, 1981. Semwal 7340.

C. pseudophragmites (Hall. f.) Koel.
Robust grass with brownish spikes. July, 1981. Semwal 7351.

Danthonia cuminsii Hook. f.
Dominant alpine grass in steep slopes. July, 1981. Semwal 7333.

Deyeuxia holciformis (Jaub. et Spach.) Bor
Robust grass on rocks, July, 1981. Semwal 7361.

D. pulchella (Griseb.) Hook. f.
Tall grass with purplish spikes. July, 1981. Semwal 7357.

Festuca kashmiriana Stapf
Grass in meadows with green spikes. July, 1981. Semwal 7345.

F. valesiaca Schleich. ex Gaud.
Grass in moist localities. July, 1981. Semwal 7274.

Phleum alpinum Linn.
Marsh grass, spikes green. June, 1978. Semwal 7120.

Poa supina Schrad.
A common grass, spikes green. June, 1978. Semwal 7112.

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Note added in proof: The author, Dr. J. K. Semwal, Scientist at the Central Institute of Medicinal and Aromatic Plants, Lucknow was a promising young taxonomist who had made significant contribution to the exploration of alpine flora of the Garhwal Himalayas. Dr. Semwal died in the field during a recent exploratory trip in the Garhwal Himalayas — Editors.

OBSERVATIONS OF THE REPRODUCTIVE BIOLOGY OF THE INDIAN CHAMELEON, *CHAMAELEO ZEYLANICUS* (LAURENTI)[1]

L. A. K. SINGH[2], L. N. ACHARJYO[3] AND H. R. BUSTARD[4]

The Indian chameleon, *Chamaeleo zeylanicus* was studied in Orissa, in captivity and in the wild. Captive specimens were housed in enclosures with ample vegetation, and maintained on an insect diet. Smallest female with functional ova was 375 mm in length. Mating occurred during the last week of August, and egg laying in October. The shape and size of the nest depended on the suitability of the ground. On soft fine sand the nest was an oblique hole, 22 cm in depth, 9 cm in diameter at the mouth. The eggs were 15-22.5 mm x 9-12 mm x 1.0-2.0 gm. There was indication of increase in size and weight of the eggs during incubation. Hatching occurred after eight months in June when small insects were available in large numbers. In three of the four cases reported, the female died within 1-42 days after egg laying. Females move less and are more territorial. Females are intolerant of close approach of other chameleons of either sex except of suitor males during a period of a few days when they are ready to mate. Mating is preceded by display by female and 'chase and escape' behaviour between the male and the female. Display by female and male (against other males) included assumption of deep green body colouration with dark spots and blotches, lateral flattening of the body, and hissing with open mouth.

INTRODUCTION

The Indian chameleon, *Chamaeleo zeylanicus,* an oviparous species, is distributed from Punjab in the north to Sri Lanka in the south (Boulenger 1890, Parshad 1914, Smith 1935, Deraniyagala 1953). Knowledge of the species' reproductive biology was based on Trench (1912). Then considered to be *Chamaeleon calcaratus,* Trench (1912) studied the behaviour of a male and female in captivity. Both individuals were obtained from 'Jubbulpore, C. P.' (= Jabalpur, Madhya Pradesh). Deraniyagala (1953) has provided preliminary data on the habits, reproduction and dimensions of male and female individuals. Biswas and Acharjyo (1977), while giving a general account on the ecology and biology of some reptiles occurring in and around the Nandankanan Biological Park, Orissa gave the species' distribution in Orissa, clutch sizes and egg measurements.

The solitary habit, procryptic behaviour and appearance make *C. zeylanicus* difficult to study in the wild, and it is difficult to keep for long periods in captivity without elaborate arrangements. Observations made on aspects of the reproductive biology in captivity and in the wild are presented in this paper.

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Materials and Methods

Two of us (LAKS and HRB) observed the species at and around the Gharial Research and Conservation Unit, Tikerpada (GRACU) within the Satkoshia Gorge Sanctuary situated in 84°47′E longitude and 20°35′N latitude, and LNA observed it at the Nandankanan Wildlife Sanctuary, in 86.25°E longitude and 20.25°N latitude. All the observations were made between 1975 and 1980.

Chameleons reared in captivity at GRACU were kept in enclosures used for rearing crocodilians. One enclosure was 23.7 x 4.9 x 2.6 m and another 12 x 12 x 2.5 m with ample vegetation cover inside. The chameleons reared at NBP were in an enclosure measuring 4 x 3 x 2.5 m. All specimens were maintained on an insect diet, and were measured and sexed when received. The base of the tail is somewhat swollen in males due to the hemepenes, which can be extruded by applying gentle pressure from back to the front.

Captive observations are based on four females — three at GRACU (CF1, CF3 and CF4) and one at NBP (CF2), and three males (CM1, CM2 and CM3) at GRACU. Observations in the wild are based on one male (WM1) and two females (WF1 and WF2) at Tikerpada.

Courtship observations were made from WM1, WF1, CF1, CM1 and CM3. Data on nesting are recorded from CF1, CF2, CF4 and WF2, and on the clutch size and female-size from WF2, CF3 and CF4. Egg biometrics and information on changes of these during incubation were obtained from clutches obtained from WF2, CF2 and CF3. Eggs were incubated in sand, kept moist at approx. 7% water by weight. No attempt was made to record the nest temperatures although the ambient temperature in a standard Stevenson Screen fluctuated between 4.5°C and 46.0°C, since the duration of incubation included winter and summer seasons. Observations on hatchlings were made possible from the nest laid by CF4 the precise location of which was not known until actual hatching took place.

Courtship and Mating

Courtship behavious was observed during the second week of August. During this period CM1 became markedly territorial towards the other males, CM2 and CM3, displaying a deep green colour with black blotches and spots and hissing loudly with laterally flattened body as has been described for *C. gracilis* by Bustard (1967). Frequently CM1 was also seen chasing the other males trying, and actually biting these, particularly on the flanks as reported for *C. gracilis* (Bustard 1967).

Initially the female was not receptive to any of the males and it moved away with vigorous rocking movements or displayed hissing with open mouth and laterally flattened body. This ‘chase and escape’ behaviour between the territory-holding male and CF1 persisted for a week except during heavy showers and at night when these chameleons used to perch asleep on the same plant at a distance of at least 15 cm.

Courting records from the wild included observation of the ‘chase and escape’ behaviour between WM1 and WF1 over two days. On the morning of the third day, at 0600 hours these had moved and could not be traced.

Mating was observed in captivity only once in the morning at 1000 hours. It lasted about three minutes. CM1 was partly over the back of CF1, holding it with all four limbs. CM1 had also bent down its hind quarters down below CF1. Both appeared motionless. After mating CF1 confined itself to a large *Butea*

superba and after a week it became territorial and displayed at CM1 and the other males, which kept away from the *Butea.*

During the period CM1 and CF1 were courting they did not eat but later they fed voraciously. The female, however, showed low appetite after about a month, and completely stopped feeding 55 days after mating.

Nesting

LNA observed CF2 on 3.10.75 at about 16.30 hours when it was unsuccessfully trying to dig a nest hole inside the enclosure. After several unsuccessful diggings, by 07.15 hours on 5.10.75 it had already laid the eggs and was covering the nest. Five eggs were still partly visible. The female was deep green and facing away from the nest with its tail held in the air. Two different types of limb actions were observed during covering the nest. In one, both fore limbs, acting alternately, dragged the soil close to the hind limbs, which, also acting alternately, pushed the soil back over the eggs. In the other type of limb action, the limbs of only one side acted at a time — the fore limb brought the soil near the hind limb of its side which in turn shifted it over the nest. During covering of the nest the female often rested for short periods and changed to the limbs of the other side. On a few occasions it also attempted to collect soil from stony areas on either side of the nest. When the female was covering the nest it reacted to any disturbance with puffed body and hissing with open mouth, the display directed towards the source of disturbance.

At about 11.30 hours covering of the nest was complete. Thereafter the female appeared tired and inactive and remained within 2 m of the nest. At about 14.00 hours on 6.10.75, the day after egg laying, it was found dead near the nest. On autopsy no more eggs were obtained from the body. On excavation of the nest, 34 eggs were collected. The nest was almost saucer shaped, 17 cm diameter and 5 cm in depth.

CF1 was observed while nesting in captivity on 20.10.75. About a week before this the female was restlessly moving in the enclosure. Suspecting that it was ready to lay eggs, a 25 cm thick sand-bed was provided but CF1 constructed its nest 4 m away from this. The details of nest construction were not recorded. However, after laying the eggs and covering the nest it too appeared exhausted and refused to eat. It was found dead on 2.11.75, 13 days after egg laying.

At about 2200 hours on 14.10.77 a group of fishermen of the Tikerpada village had located WF2 on the sand of a nearby stream. They kept the chameleon under a bucket and brought it to GRACU on the next morning. It had moist sand smeared all over the limbs and head. On questioning, the fishermen informed that "it had dug a hole in an attempt to escape out of the bucket cover". On an examination at the spot the hole was found to be obliquely dug, 10 cm deep and 7 cm diameter at the mouth. On digging it further 32 eggs were recovered within 15-20 cm depth from the surface. About 20 m away on the bank there was a 'pit', 12 cm deep and 9 cm diameter at the mouth. Further away from this another equal-size pit was located among the bushes. Both these pits were dug oblique to the ground and presented a superficial resemblance to the actual uncovered nest with the eggs. However, these were not fresh and it could not be ascertained if these were dug by WF2.

Eggs collected from the nest by WF2 were kept under incubation in an enclosure in two divided batches. The female, also kept in the

same enclosure, refused to accept any food and died after 42 days, on 25.11.77.

The nest of CF4, which was discovered after the young hatched, was dug in sand and was 22 cm deep and 10.5-11.0 cm in diameter at the bottom. Like other females which had nested, CF4 also died in captivity. Since the exact date of egg-laying was not known, the date of the death cannot be related to nesting.

The Eggs

At an early stage of development the ova are pinkish in colour. At postmortem on 4.6.77 a female, outside the present study sample, contained over fifty developing ova, all pinkish in colour and 1-3 mm in diameter. The female measured 375 mm in total length, 175 mm in snout-vent length and 105 gm in weight.

Gravid females had yellowish-red patches on the lower half of the body and thus were readily recognised. Such females also had a skinny appearance with extended abdomens where eggs could be felt when the abdomen was gently palpated. CF3, a freshly killed female received at GRACU on 3.10.75, measured 200 mm for SV (snout-vent) and weighed 153.5 gm. The tail was missing as it had been removed for medicinal use. The oviducts contained 40 eggs, weighing in total 43.0 gm (mean 1.075 gm). A sample of ten eggs measured as below: 5 eggs were 19 x 12 mm, 2 eggs 19.5 x 12 mm, 1 egg each 20 x 12 mm, 21 x 11 mm and 22.5 x 11 mm. The eggs were fully formed with white shell, clearly on the point of deposition.

The eggs from the clutch laid by CF2 were 1.0-1.1 gm in weight, 15-18 mm in length and 9-11 mm in breadth. The female was not measured.

Of the 32 eggs collected from the clutch of WF2 31 were normal — 18.15-20.0 mm in length, 10.5-11.5 mm in breadth and 1.25-2.0 gm in weight, and one was smaller than the rest — 16.0 mm x 9.0 mm x 1.0 gm.

CF4, measuring 170 mm in SV, 380 mm in total length and weighing 115 gm had laid a clutch of 34 eggs. (Table 1).

Incubation and Development

Eggs of none of the clutches obtained from CF1, CF2, CF3 and WF2 hatched. However, measurements and weights of eggs from the clutches of CF2, CF3 and WF2 showed slight increase in size and weight during incubation (Table 2). The study could not be pursued since the eggs spoiled due to rotting or ant-invasion.

Table 1

Size of three female *Chamaeleo zeylanicus* and their clutch size

Female Chameleon	Date measured	Total body length (mm)	Snout-vent length (mm)	Body-weight (gm)	Clutch size (no.)
CF3	3.10.75	—	200	153.5 (with eggs)	40
CF4	18.9.77	380	170	115 (with eggs)	34
WF2	14.10.77	365	170	72 (no eggs)	32

TABLE 2

CHANGE IN THE EGG SIZE AND WEIGHT OF EGGS OF *C. zeylanicus* ARTIFICIAL INCUBATION

Chameleon no.	Stage of incubation (weeks)	No. of eggs measured	Egg length (mm)	Egg breadth (mm)	Egg weight (gm)
CF3	0	10	19.0–22.5	11.0–12.0	1.075 av.
	2	10	19.0	12.0	2.0
CF2	0	10	15.0–18.0	9.0–11.0	1.0–1.1
	4	10	17.0–19.0	11.0–12.0	1.3–1.5
	11	3	19.0–21.0	12.0–13.0	2.0–2.3
WF2	0	31	18.25–20.0	10.5–11.5	1.2–2.0
	5	12	21.5–22.75	12.2–13.2	1.5–2.0
	9	7	22.2–24.0	13.0–14.0	2.5–3.0

HATCHING

Between 21.6.78 and 23.6.78 nine living and two dead chameleon hatchlings were found close to the nest of CF4. Upon examination of the nest the following information was recorded. At the surface the nest had two small openings, through which the hatchlings had escaped. The openings were approx. 1.5 cm in diameter and 2.0 cm apart. Hatching had taken place in the early morning of 21.6.78 because inspite of a 29 mm rain during the previous night the holes were not blocked with sand.

The nest contained a total of 34 eggs of which white and empty shells numbered 15 (hatching of 44.1%), black empty shells indicating early fungal attack in 7 eggs (20.5%), eggs with early embryonic mortality 5 (14.7%) and with late embryonic mortality 7 (20.5%). Dead late-stage embryos were found in the egg with limbs folded and directed forward and tail coming forward almost to the neck and twisted round it from its left. The tongue was slightly protruded in all dead embryos.

THE HATCHLING

When discovered, the hatchlings were green in colour, showing slow rocking movements like the adults. Defensive behaviour was also like the adult — laterally flattened body, assumption of black blotches over the green coloration and hissing with low noise from open mouth. The hatchlings were different from the adults in not possessing the casque although the head at this presumptive area was slightly convex. Four live hatchlings measured 70.0-72.5 mm (total length), 33.0-34.5 mm (SV), and seven hatchlings weighed 6.5 gm (mean 0.92 gm).

DISCUSSION

Bustard (1965, 1966a) provided the details of colour, body shape and behaviour in *C. hohnelii* and *C. bitaeniatus* to distinguish the sexes. There is, however, no noticeable sexual dichromatism in *C. zeylanicus,* except that gravid females exhibit yellowish-red blotches

on the lower half of the abdomen. Trench (1912) has also mentioned of a change in the colour of his female chameleon during the period following mating. But Deraniyagala (1953) has not mentioned any such colour difference in the sexes although he has noted that males are larger than the females.

The gravid female colouration advertises the condition of the female and is a direct parallel to the dominant and non-dominant colour patterns shown by *C. hohnelii* (Bustard 1965). Presumably it has a similar function of preventing unnecessary interaction/conflict situations by preventing males making unnecessary mating attempts which could be rebuffed.

As described for *C. hohnelii, C. bitaeniatus* and *C. gracilis* (Bustard 1965, 1966a, 1967), in *C. zeylanicus* too, colour display plays an important role in social behaviour.

Female *C. zeylanicus,* like most *Chamaeleo* species, are intolerant of close approach of other chameleons of either sex except for suitor males during a period of a few days when they are ready to mate. Actual mating is preceded by a prolonged 'chase and escape' behaviour which is explicable in an analogy to other vertebrates (Manning 1972) where because of the solitary nature, the first response of a potential mate to the other's approach may show elements of attack and escape Since coloration has not been observed to be a sex-advertising sign in *C. zeylanicus* at this stage of the life, the immediate response of a territory-holding female to a male is of that towards an intruder. This response results in display. Later, following a male's continued attempt at contact, the response is escape. Perhaps some chemical communication comes into play at a still later stage to effect mating.

Bustard (1965) mentions for *C. hohnelii* that the tendency for males to wander may be important in increasing the probability of their locating mates, since they are solitary animals. Similar to the above observation, for *C. zeylanicus* too, we believe that the males wander more than the females because during this study and from our unpublished records we noticed many more males than females — an observation also recorded by Biswas and Acharjyo (1977).

Male displays are directed only to other males competing or thought to be competing to court a female. Such male displays include close approach, pausing to inflate and hiss, and attacks on the flanks. These male displays have also been recorded by Bustard (1965) in *C. hohnelii.*

Females on the other hand move less. The post-mating male avoidance behaviour of the female is highly pronounced. Trench (1912), who had also noticed this, stated: after mating the female "showed rage if the male came near her, rocking her body to and fro and gaping at him with faint hissings. He on the other hand would fly in ludicrous terror falling head long from his perch if she came near, as though paralysed."

Position taken during mating — male holding the female with all four limbs — is similar to the description given earlier by Trench (1912) for this species (*C. zeylanicus*) and by Schreiber (1912) for *C. chameleon,* Bustard (1963) for *Microsaura pumila* and Bustard (1966a) for *C. bitaeniatus.*

Fully formed eggs were seen in autopsy of females during the middle of September but egg laying began only between the 1st and 3rd weeks of October. Actual laying of eggs occurred after two days of digging — an observation also recorded by Trench, who, however, mentioned egg-laying in November. The difference in this may be due to the difference in latitude. (Trench made his observation at Jabalpur, Madhya Pradesh at approx. 23°N

and 80°E.) Deraniyagala (1953) have mentioned of a female captured at Marichchukate in November, 1933 that contained 22 eggs.

Deraniyagala (1953) have noted that the gestation period is one month for *C. zeylanicus.* In the present study the gap between mating and egg laying is from six to eight weeks.

In the present study four females have been noted as dying after egg laying. CF2 died after the day of nesting, CF1 after 13 days, WF2 (caught from the wild) after 42 days, and for CF4 the gap period is not known.

The shape and size of the nests depended on the nature of the ground in which these were dug. When the ground was of soft, fine, sand the nest was an oblique hole up to 22 cm deep and 9 cm diameter at the mouth, but when the ground was hard the nest was wider (17 cm) and shallower (5 cm). About two days of unsuccessful digging may precede actual completion of nest digging and egg laying.

Egg sizes provided for the species by Trench (1912) are 13 x 7 mm, by Smith (1935) 19 x 12 mm, by Deraniyagala (1953) 18-19 x 12-12.5 mm, and by Biswas and Acharjyo (1977) 16-19 x 10-12 mm. In the present study the measurements recorded were 15.0-22.5 x 9-12 mm x 1.0-2.0 gm. From Table 2 it is noted that during incubation the eggs tend to increase in size and weight as is observed in agamid eggs (Bustard 1966b). Since the chameleonidae are considered to be a descendant from agamid stock, certain behavioural similarities as pointed out by Bustard (1965) are expected.

The incubation period was eight months, which is apparently timed so that the hatchlings emerge when there is abundant small insect food at the onset of the monsoon in June.

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NEW RECORDS AND HOSTS OF APHID PARASITOIDS (HYMENOPTERA: APHIDIIDAE) FROM KASHMIR, INDIA[1, 2]

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New records of Aphidiid parasitoids reared from various aphid species together with records of new host aphids of earlier recorded Aphidiid species in Kashmir are presented. 12 species of aphid parasitoids are new to India and 5 species new to Kashmir. Host-Parasitoid list is added, showing 87 different couples of host/parasitoid.

INTRODUCTION

Aphidiid parasitoids are internal parasites of aphids. Earlier the aphid parasitoid fauna of Kashmir has been studied by Dharmadhikari & Ramaseshia (1970); Rishi & Zutshi (1973 & 1979); Shuja Uddin (1973-1974, 1975 & 1978) and Stary & Bhagat (1978). These papers record a total of 19 Aphidiid species from the valley of Kashmir. Additional Aphidiid parasitoids are being recorded from this region in this paper. 12 species which have been recorded as new to India and are marked with an asterisk and 5 species newly recorded from Kashmir are marked with a double asterisk and a number of additional new aphid hosts of some already recorded parasitoids are marked with a dagger. The total number of aphid parasitoids known to occur in Kashmir is 36. The aphid parasitoid species have been obtained by random collecting and breeding of parasitized aphid samples from different localities and habitats of Kashmir. The 87 different host/parasitoid couples recognized for the first time in India during the present study are incorporated in he Host-Parasitoid list. For the host aphid nomenclature, Eastop & Hille Ris Lambers (1976) has been followed.

OBSERVATIONS

*1. **Aphidius areolatus** Ashmead

Hosts: *Periphyllus aesculi* Hille Ris Lambers, Lal Mandi, Srinagar, 30.v.1976, from *Aesculus indica; Periphyllus vandenboschi* Hille Ris Lambers, Khilanmarg (Gulmarg), 28.vi.1976, from *Acer caesium.*

*2. **Aphidius avenae** Haliday

Hosts: *Chaetosiphon glaber* David, Rajasingha and Narayanan, Shankaracharya hill, Srinagar, 26.x.1975, from *Rosa* sp.; *Macrosiphum* sp., Peri Mahal, Srinagar, 7.v.1977, from *Rosa macrophylla; Myzaphis turanica* Nevsky, Kangan, 28.v.1978, from *Rosa* sp.

*3. **Aphidius eglanteriae** Haliday

Hosts: *Chaetosiphon tetrarhodum* (Walker), Dachigam, 15.vi.1976, from *Rosa macrophylla; Myzaphis rosarum* (Kaltenbach), Lal Mandi, Srinagar, 5.v.1977, from *Rosa webbiana.*

4. **Aphidius ervi Haliday

Hosts: *Microlophium evansi* Theobald, Arizal, Beerwah, 12.vii.1977, from *Urtica dioica; Acrythosiphon* sp., Hazratbal, Srinagar, 18.v.1978, from *Vicia sativa.*

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*5. **Aphidius gifuensis** Ashmead

Hosts: *Aphis affinis* Del Guercio, Manasbal, 15.iv.1977, from *Mentha longifolia; Aphis* sp., Harvan, 21.x.1975, from *Nepeta salvifolia; Aphis* sp., Hazratbal, Srinagar, 3.vi.1978, from *Veronica persicae; Aphis* sp., Naseem Bagh, Srinagar, 4.vi.1978, from *Vicia sativa.*

6. **Aphidius matricariae** Haliday

†*Hosts*: *Aphis* sp., Oberoi Palace, Srinagar, 3.xi.1978, from *Cynoglossum glochidatum; Microlophium carnosum* Buckton, Srinagar, 3.xi.1978, from *Urtica dioica; Capitophorus elaeagni* van der Goot, Peri Mahal, Srinagar 22.ix.1975; from *Carduus edelbergi.*

*7. **Aphidius salicis** Haliday

Hosts: *Aphis* sp., Peri Mahal, 16.v.1976, from *Dioscorea deltoides; Cavariella biswasi* Ghosh, Basu and Raychaudhuri, Zabervan, Srinagar, 25.v.1975. from *Ferula jaeschkeana.*

8. **Aphidius smithi Sharma & Subba Rao

Hosts: *Acrythosiphon* sp., Gulmarg, 8.vii. 1977, from *Ranunculus muricatus; Acrythosiphon* sp., Naseem Bagh, Srinagar, 28.v.1978, from *Medicago sativa.*

9. **Aphidius uzbekistanicus** Luzhetzki

†*Host*: *Impatientinum impatiens dalhousiensis* Verma, Lolab Valley, 3.x.1977, from *Impatiens.* sp.

10. **Aphidius** spp.

Hosts: *Aphis farinosa* Gamelin, Khilanmarg, 28.vi.1976, from *Salix aegyptica; Capitophorus* sp., Chararisherief, 13.vi.1977, from *Carduus* sp.; *Chaetosiphon* sp., Dachigam, 25.v. 1977, from *Rosa* sp., *Lachnus tropicalis* (van der Goot), Zabervan, Srinagar, 16.v.1977, from *Pinus wallichiana; Rhopalosiphum nymphaeae* Linneus, Hazratbal, Srinagar, 15.v.1977, from *Nymphaea alba.*

11. **Diaeretiella rapae** (M' Intosh)

†*Hosts*: *Brevicoryne brassicae* (Linnaeus), Srinagar, 23.x.1975, from *Brassica oleracea* var. *acephala; Uroleucon sonchi* (Linnaeus), Srinagar, 30.v.1976, from *Sonchus oleraceous.*

12. **Ephedrus persicae** Froggatt

†*Hosts*: *Chaitophorus populeti* (Panzer), Peri Mahal, Srinagar, 25.v.1975, from *Populus caspica; Melanaphis donacis* (Passerini), Hazratbal, Srinagar, 25.x.1976, from *Arundo donax; Tetraneura* sp., Ducksum 17.vi.1977, from *Ailantus altissma.*

13. **Ephedrus plagiator** (Nees)

†*Hosts*: *Prociphilus* sp., Zabervan, Srinagar, 25.v.1975, from *Lonicera quinquelocularis; Tetraneura* sp., Ducksum, 17.v.1975, from *Ailantus altissma.*

*14. **Ephedrus salicicola** Takada

Hosts: *Cavariella* sp., Srinagar, 30.vi.1975, from *Salix babylonica; Eumyzus* sp., Kangan near Prang, 28.v.1977, from *Nepeta cataria.*

15. **Lipolexis gracilis Forster

Hosts: *Acyrthosiphon rubi* Narzikulov, Hazratbal, Srinagar, 7.vii.1975, from *Rubus fruticosus; Aphis affinis* Del Guercio, Bandipore, 4.viii.1975, from *Mentha aquatica,* and Haigam, 3.viii.1977, from *Mentha sylvestris; Aphis gossypii* Glover, Cheshamashi, Srinagar, 30.viii.1975, from *Zinnia elegans; Aphis craccivora* Koch, Hazratbal, 6.vii.1975, from *Robinia pseudoacacia.*

*16. **Lysiphlebus (Phlebus) confusus** Tremblay & Eady

Hosts: *Aphis* nr. *intybi* (Koch), Harvan near Dachigam, 30.vi.1975, from *Cichorium intybus; Chaitophorus niger* Mordvilko, Chitarnar, Bandipore, 4.viii.1975, from *Populus caspica; Sipha* (*Rungsia*) *maydis* Passerini, Hazratbal, Srinagar, 15.viii.1976, from *Sorghum halepense.*

17. **Lysiphlebus (Phlebus) fabarum (Marshall)

Hosts: *Acyrthosiphum rubi* Narzikulov, Hazratbal, Srinagar, 7.viii.1975, from *Rubus fruticosus; Aphis craccivora* Koch; Srinagar, 7.viii.1975, from *Robinia pseudoacacia; Aphis*

fabae solanella Theobald, Zeetyer, Srinagar, 31.viii.1975, from *Rumex nepalensis; Aphis* nr. *salviae* Walker, Shankaracharya hill, Srinagar, 6.ix.1975, from *Salvia moorcraftiana.*

***18. Monoctonus crepidis** (Haliday)

Hosts: *Liosomaphis atra* Hille Ris Lambers, Kokernag, 23.v.1977, from *Berberis pseudoumbellatus; Liosomphis* sp., Cheshmashahi, 12.v.1976, from *Berberis zebbiliana.*

19. Praon abjectum (Haliday)

†*Hosts*: *Aphis farinosa* Gmelin, Srinagar, 28.iv.1976, from *Salix babylonica; Aphis grossulariae* nr. *pollinosa* Walker, Kokernag, 15.x.1977, from *Epilobium hirsutum; Aphis* sp., Harvan, 21.x.1975, from *Nepeta salvifolia; Melanaphis donacis* (Passerini), Hazratbal, Srinagar, 14.x.1976, from *Arundo donax; Myzaphis rosarum* (Kaltenbach), Kokernag, 23.v.1977, from *Rosa* sp.;

***20. Praon dorsale** (Haliday)

Hosts: *Amphicercidus tuberculatus* David, Narayanan & Rajasingha, Dachigam, 25.v.1977, from *Lonicera quinquelocularis; Macrosiphoniella sanborni* (Gillette), Cheshmashahi, Srinagar, 18.v.1976, from *Chrysanthemum morifolium.*

****21. Praon nympheae** Subba Rao and Sharma

Hosts: *Rhopalosiphum nymphaeae* (Linnaeus), Nagin Lake, Srinagar, 15.v.1977, from *Nymphaea* sp.

22. Praon volucre (Haliday)

†Hosts: *Aphis* sp., Cheshmashahi, Srinagar, 4.x.1975, from *Lespedeza* sp.; *Hyalopterus arundinis* (Fabricius), Srinagar, 26.v.1975, *Prunus domestica; Hyalopterus pruni* (Geoffroy), Nagin Lake, Srinagar, 9.vii.1975, from *Phragmites communis; Hypermyzus lactucae* (Linnaeus), Srinagar, 5.vi.1976, from *Sonchus oleraceus; Macrosiphum* sp., Srinagar, 30.v.1976, from *Rosa* sp.; *Myzaphis turanica* Nevsky, Kangan, 28.v.1978, from *Rosa* sp.; *Liosomaphis atra* Hille Ris Lambers, Nishat Garden, Srinagar, 23.v.1976, from *Berberis pseudoumbellatus; Uroleucon* sp., Verinag, 15.viii.1977, from *Sonchus asper.*

23. Toxares deltiger Westwood

†Hosts: *Betacallis* sp., Aharbal, 5.viii.1975, from *Conium maculatum; Eumyzus* sp., Kangan, 28.v.1977, from *Nepeta cataria; Ovatus* nr. *crataegarius* Walker, Gulmarg, 3.vii.1975, from *Mentha longifolia; Prociphilus* sp., Aharbal, 5.vii.1977, from *Lonicera quinquelocularis.*

24. Trioxys (Binodoxys) acalephae (Marshall)

†Hosts: *Aphis affinis* Del Guercio, Brujhoma, 13.ix.1975, from *Mentha sylvestris; Macrosiphum* sp., Zabervan, Srinagar, 7.v.1977, from *Rosa* sp.

25. Trioxys (Binodoxys) brevicornis (Haliday)

†Host: *Chaitophorus pakistanicus* Hille Ris Lambers, Naseem Bagh, Srinagar, 28.iv.1976, from *Salix babylonica.*

26. Trioxys (Binodoxys) centaureae (Haliday)

†*Hosts*: *Capitophorus elaeagni* (Del Guercio), Chararisharief, 13.vi.1977, from *Macrosiphoniella artimisae* (Boyer de Fonscolombe), Shankracharya, Srinagar, 6.ix.1975, from *Artemisia indica; Macrosiphoniella* sp., Cheshamashahi, Srinagar, 18.iv.1976, from *Achillea millefolium.*

27. Trioxys (Binodoxys) indicus Subba Rao and Sharma

†*Hosts*: *Aphis affinis* Del Guercio, Dachigam, 25.v.1975, from *Mentha sylvestris; Aphis fabae solanella* Theobald, Prang near Kangan, 20.v.1977, from *Rumex nepalensis; Aphis gossypii* Glover, Shopian, 5.vi.1977, from *Urtica dioica,* and Hazratbal, Srinagar, 14.vi.1977, from *Melia azedarach; Aphis pomi* De Geer, Naseem Bagh, Srinagar, 14.vi.1975, from *Pyrus malus; Eriosoma* sp., Hazratbal, Srinagar, 22.vi.1975, from *Cotoneaster aitkinsonii; Macrosiphoniella pseudoartemisiae*

Shinji, Shankracharya, Srinagar, 1.v.1975, from *Artemisia absinthium; Macrosiphum* sp., Srinagar, 8.v.1975, from *Rosa brunonii; Mindarus japonicus* Takahashi, Khilanmarg 28.vi.1976, from *Abies pindrow; Paraphorodon* sp., Hariparvat, Srinagar, 21.v.1976, from *Punica granata.*

***28. Trioxys (Trioxys) complanatus** Quilis

Hosts: *Acyrthosiphum pisum* Harris, Naseem Bagh, Srinagar, 30.iv.1978, from *Lathyrus aphaca; Therioaphis* sp., Hazratbal, Srinagar, 30.iv.1978, from *Vicia sativa.*

***29. Trioxys (Trioxys) pannonicus** Stary

Host: *Macrosiphoniella* nr. *artemisiae* Boyer de Fonscolombe, Shankracharya, Srinagar, 6.ix.1975, from *Artemisia absinthium.*

30. Trioxys (Trioxys) rishii Stary and Bhagat

†*Hosts*: *Aphis craccivora* Koch, Srinagar, 25.vi.1975, from *Robinia pseudoacacia; Aphis pomi* De Geer, Hariparvat, Srinagar, 1.v.1976, from *Malus sylvestris; Capitophorus elaeagni* Shankracharya, Srinagar, 16.vi.1976, from *Carduus* sp.; *Phorodon cannabis* Passerini, Handwara, 5.ix.1977; from *Cannabis sativa.*

***31. Trioxys (Trioxys) shivaphis** Takada

Host: *Shivaphis celti* Das, Emporium Garden, Srinagar, 15.v.1978, from *Celtis australis.*

Aphid host — Parasitoid list

ACYRTHOSIPHON

A. pisum (Harris)
Trioxys (T.) complanatus Quilis
A. rubi Narzikulov
Lipolexis gracilis Forster
Lysiphlebus (P.) fabarum (Marshall)
Acyrthosiphon sp.
Aphidius ervi Haliday
Aphidius smithi Sharma & Subba Rao

AMPHICERCIDUS

A. tuberculatus David *et al.*
Praon dorsale (Haliday)

APHIS

A. affinis Del Guercio
Aphidius gifuensis Ashmead
Lipolexis gracilis Forster
Trioxys (B.) acalephae (Marshall)
Trioxys (B.) indicus Subba Rao & Sharma
A. craccivora Koch
Lipolexis gracilis Forster
Lysiphlebus (P.) fabarum (Marshall)
Trioxys (T.) rishii Stary & Bhagat
A. fabae solanella Theobald
Lysiphlebus (P.) fabarum (Marshall)
Trioxys (B.) indicus Subba Rao & Sharma
A. farinosa Gamelin
Praon abjectum (Haliday)
Aphidius sp.
A. gossypii Glover
Lipolexis gracilis Forster
Trioxys (B.) indicus Subba Rao & Sharma
A. grossulariae Kaltenbach
Praon abjectum (Haliday)
A. nr. **salviae** Walker
Lysiphlebus (P.) fabarum (Marshall)
A. nr. **intybi** Koch
Lysiphlebus (P.) confusus Tremblay & Eady
A. pomi De Geer
Trioxys (B.) indicus Subba Rao & Sharma
Trioxys (T.) rishii Stary & Bhagat
Aphis spp.
Aphidius gifuensis Ashmead
Aphidius matricariae Haliday
Aphidius salicis Haliday
Praon abjectum (Haliday)
Praon volucre (Haliday)

BETACALLIS

Betacallis sp.
Toxares deltiger Westwood

BREVICORYNE

B. brassicae (Linnaeus)
Diaeretiella rapae (M'Intosh)

CAPITOPHORUS

C. elaeagni (Del Guercio)
Aphidius matricariae Haliday
Trioxys (B.) centaureae (Haliday)
Trioxys (T.) rishii Stary & Bhagat
Capitophorus sp.
Aphidius sp.

CAVARIELLA
C. biswasi Ghosh, Basu & Raychaudhuri
Aphidius salicis Haliday

Cavariella sp.
Ephedrus salicicola Takada

CHAETOSIPHON
C. glaber David, Rajasingh & Narayanan
Aphidius avenae Haliday
C. tetrarhodum (Walker)
Aphidius eglanteriae Haliday
Chaetosiphon sp.
Aphidius sp.

CHAITOPHORUS
C. niger Mordvilko
Lysiphlebus (P.) confusus Tremblay & Eady
C. pakistanicus Hille Ris Lambers
Trioxys (B.) brevicornis (Haliday)
C. populeti (Panzer)
Ephedrus persicae Froggatt

ERIOSOMA
Eriosoma sp.
Trioxys (B.) indicus Subba Rao & Sharma

EUMYZUS
Eumyzus sp.
Ephedrus salicicola Takada
Toxares deltiger Westwood

HYALOPTERUS
H. arundinis (Fabricius)
Praon volucre (Haliday)
H. pruni (Geoffroy)
Praon volucre (Haliday)

HYPERMYZUS
H. lactucae (Linnaeus)
Praon volucre (Haliday)

IMPATIENTINUM
I. dalhousiensis Verma
Aphidius uzbekistanicus Luzhetzki

LACHNUS
L. tropicalis van der Goot
Aphidius sp.

LIOSOMAPHIS
L. atra Hille Ris Lambers
Monoctonus crepidis (Haliday)
Lisomaphis sp.
Monoctonus crepidis (Haliday)

MACROSIPHONIELLA
M. artemisiae (Boyer de Fonscolombe)
Trioxys (B.) centaureae (Haliday)
M. nr. **artemisiae** (Boyer de Fonscolombe)
Trioxys (T.) pannonicus Stary
M. pseudoartemisiae Shinji
Trioxys (B.) indicus Subba Rao & Sharma
M. sanborni (Gillette)
Praon dorsale (Haliday)
Macrosiphoniella sp.
Trioxys (B.) centaureae (Haliday)

MACROSIPHUM
Macrosiphum sp.
Aphidius avenae Haliday
Praon volucre (Haliday)
Trioxys (B.) acalephae (Marshall)
Trioxys (B.) indicus Subba Rao & Sharma

MELANAPHIS
M. donacis (Passerini)
Ephedrus persicae Froggatt
Praon abjectum (Haliday)

MICROLOPHIUM
M. carnosum (Buckton)
Aphidius matricariae Haliday
M. evansi Theobald
Aphidius ervi Haliday

MINDARUS
M. japonicus Takahashi
Trioxys (B.) indicus Subba Rao & Sharma

MYZAPHIS
M. rosarum (Kalenbach)
Aphidius eglanteriae Haliday
Praon abjectum (Haliday)
M. turanica Nevsky
Aphidius avenae Haliday
Praon volucre (Haliday)

OVATUS
O. nr. **crataegarius** (Walker)
Toxares deltiger Westwood

PERIPHYLLUS
P. aesculi Hille Ris Lambers
Aphidius areolatus Ashmead
P. vandenboschi Hille Ris Lambers
Aphidius areolatus Ashmead

PARAPHORODON
Paraphorodon sp.
Trioxys (B.) indicus Subba Rao & Sharma

PHORODON
P. cannabis Passerini
Trioxys (T.) rishii Stary & Bhagat

PROCIPHILUS
Prociphilus sp.
Ephedrus plagiator (Nees)
Toxares deltiger Westwood

RHOPALOSIPHUM
R. nymphaeae (Linnaeus)
Aphidius sp.
Praon nympheae Subba Rao & Sharma

SHIVAPHIS
S. celti Das
Trioxys (T.) shivaphis Takada

SIPHA
S. maydis Passerini
Lysiphlebus (P.) confusus Tremblay & Eady

TETRANEURA
Tetraneura sp.
Ephedrus persicae Froggatt
Ephedrus plagiator (Nees)

THERIOAPHIS
Therioaphis sp.
Trioxys (T.) complanatus Quilis

UROLEUCON
U. sonchi (Linnaeus)
Diaeretiella rapae (M' Intosh)
Uroleucon sp.
Praon volucre (Haliday)

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HOST PLANTS OF THE FRUIT FLIES (DIPTERA: TEPHRITIDAE) OF THE INDIAN SUB-CONTINENT, EXCLUSIVE OF THE SUB-FAMILY DACINAE[1]

Mohammad Zaka-ur-Rab[2]

In the Indian sub-continent (including India, Pakistan, Sri Lanka, Nepal and Bangladesh), the Tephritidae are represented by 60 genera and 138 species, out of which 56 genera and 102 species belong to sub-families other than the Dacinae. Very little work has been done on the biological aspects of the non-Dacine Tephritidae of the region. This can be gauged from the fact that out of 102 species comprising this group, host plants of only 21 species are known with any degree of certainty.

In the present paper, an attempt has been made to place on record the information hitherto available about the known cultivated as well as wild host plants of the larvae of non-Dacine Tephritidae of the region.

Introduction

The Tephritidae represent a family of rather conspicuous looking flies whose larvae are entirely phytophagous and show intricate anatomical as well as behavioural adjustments for successfully leading such a mode of life. The only exception perhaps is the Australian tephritid *Rioxa termitoxena* which breeds in the burrows of the tree-dwelling termites, *Mastotermes darwiniensis* and *Calotermes irregularis*, the larvae subsisting on a foul smelling liquid lying within the termite tunnels. Another closely related example is that of *Rioxa modestum* (Fab.) which was recorded by Bezzi (1913) as having been bred from decaying wood at Calcutta in West Bengal.

In the Indian sub-continent, the Tephritidae are represented by 60 genera and 138 species out of which 56 genera and 102 species belong to sub-families other than Decinae.

Very little work has been done on the biology of the non-Dacine Tephritidae of the region. This can be gauged from the fact that out of 102 species comprising this group, host plants of only 21 species are known with any degree of certainty. Even where we know something about the host plants of any particular species, it seems that the total range of the latter has not been adequately explored.

Members of the sub-family Trypetinae are mostly fruit feeders although some of them also cause galls or damage seed pods etc. The fruit feeders mostly live on the fleshy portions of wild and cultivated fruits but do not damage their seeds. However, those species which cause galls considerably reduce the vigour of their host plants and can be effectively utilised as biological control agents for combating harmful weeds. Use of *Procecidochares utilis* for controlling the Crofton weed, *Eupatorium adenophorum*, in Hawaii, Australia, New Zealand, India and Nepal, is one such example.

Members of the sub-family Tephritinae, on the other hand, usually infest flower heads of various plants and destroy the seeds develop-

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ing therein. While this may amount to serious economic losses in cultivated crops by reducing the seed yields, a large proportion of these species can serve as useful biological control agents for keeping the reproductive potential of noxious weeds under effective check by destroying their seeds.

It is now widely known that a number of plant pests are able to survive and multiply on wild plants which serve as their alternative hosts. For an effective control of such pests it is obviously useful to have as much information as possible about their wild alternative hosts. This is also highly desirable in view of the role played by such wild hosts in the multiplication and augmentation of populations of parasites and predators of various economic pests.

The following text is an attempt to place on record the information hitherto available about the cultivated as well as wild host plants of the larvae of fruit flies (exclusive of subfamily Dacinae) of the Indian sub-continent comprising of India, Pakistan, Sri Lanka, Nepal and Bangladesh.

Sub-family TRYPETINAE

Anoplomus flexosus Bezzi

Cultivated host: *Morus* sp.

(Misra 1920, Kumaon, U.P.; Mathur and Singh 1959).

Wild host: Unknown

Carpomyia vesuviana Costa

Cultivated host: *Zizyphus jujuba* Lam. (=*Z. mauritiana* Lam.)

(Batra 1953; Narayanan and Batra 1960; Pruthi and Batra 1960; Usman and Puttarudraiah 1955; Fletcher 1920, 1917; Khare 1923; Basha 1952).

Wild host: *Zizyphus nummularia* W. and A.

(Batra 1953; Narayanan and Batra 1960; Pruthi and Batra 1960).

Z. vulgaris Lam. (=*Z. sativa* Gaertn., *Z. jujuba* Mill.)

(I reared this fruit fly from infested fruits of *Z. vulgaris* at Srinagar, Sopore, Bandipur and Baramulla in Kashmir where these trees grow wild. This is the first record of *C. vesuviana* from Kashmir, as well as from this host in the Indian sub-continent).

Note: This fruit fly is widely distributed throughout the sub-continent, and is found where-ever *Zizyphus* trees grow.

Ceratitella asiatica Hardy

Cultivated host: Unknown

Wild host: *Loranthus longiflorus* Desv.

(Hardy 1967, at Kahuta, Pakistan, infesting fruits).

Ceratitis capitata (Wied.)

Cultivated host: *Prunus persica* Stokes

(Munro 1938, bred from peach at Pusa, Bihar in 1907 but not subsequently reported).

Wild host: Unknown

Ceratitis sp.

Cultivated host: Unknown

Wild host: *Dendrocalamus giganteus* Munro

(Mathur and Singh 1959, larvae boring in new shoots).

Chaetellipsis paradoxa Bezzi
(= *Poecilis judicauda* Bezzi)

Cultivated host: Unknown

Wild host: *Bambusa burmanica* Gamble

(Bhasin, Roonwal and Singh 1958, breeding in damaged shoots, larva tunnels on outside of node between epidermis and culm sheath).

Chelyophora ceratitina (Bezzi)
(= *Stictaspis ceratitina* Bezzi)

Cultivated host: Unknown

Wild host: *Dendrocalamus strictus* Nees

(Mathur and Singh 1959, infesting shoots).
Bamboos
(Bhasin, Roonwal and Singh 1958, infesting green shoots, larva completely eats out the soft tissue leaving only the culm sheath; Fletcher 1920, at Pusa, Bihar).

Chelyophora striata (Froggatt)

Cultivated host: Unknown
Wild host: *Bambusa vulgaris* Schrad.
(Bhasin, Roonwal and Singh 1956, infesting green shoots).
Dendrocalamus giganteus Munro
D. strictus Nees
(Mathur and Singh 1959, larvae boring in shoots; Fletcher 1920, Sri Lanka, infesting shoots).

Craspedoxantha octopunctata Bezzi

Cultivated host: *Centaurea americana* Nutt.
(Menon, Kapoor and Mahto 1968, Delhi, breeding in flowers).
Wild host: *Gonicaulon glabrum* Cass.
(Senior-White 1922, Nagpur, infesting flowers).

Gastrozona melanista Bezzi

Cultivated host: Unknown
Wild host: *Ficus* sp.
(Usman and Puttarudraiah 1955, Chikmaglur, infesting wild figs).

Myiopardalis pardalina (Bigot)

Cultivated host: *Citrullus vulgaris* Schrad.
Cucurbita maxima Duch.
C. pepo L.
Cucumis melo L.
C. sativus L.
(Janjua 1954; Janjua and Samuel 1941; Pruthi and Batra, 1960; Narayanan and Batra 1960).
Wild host: *Cucumis trigonus* Roxb.
(Misra 1920, at Pusa, Bihar; Janjua 1954; Pruthi and Batra 1960; Narayanan and Batra 1960).

Note: This fruit fly has been recorded from all parts of Pakistan except Sind, and is a very serious pest of cultivated melons particularly in Baluchistan. Reports of its occurrence in various parts of India, however, have been rather few and far between. It appears likely that such chance records were based on infested fruits imported from Pakistan.

Phaeospilodes bambusae Hering

Cultivated host: Unknown
Wild host: Bamboo
(Hering 1940, Coimbatore, bamboo shoots).

Procecidochares utilis Stone

Cultivated host: Unknown
Wild host: *Eupatorium adenophorum* Sprengel
(Kapoor and Malla 1978, at Kathmandu, Nepal, causing gall formation at junction of two leaves or leaf petiole; Kapoor, Malla and Ghosh 1979).

Rhacochlaena cassiae Munro

Cultivated host: *Cassia fistula* L.
(Bhasin, Roonwal and Singh 1958, larvae boring in pods).
Wild host: Unknown

Sub-family TEPHRITINAE

Acanthiophilus helianthi Rossi

Cultivated host: *Carthamus tinctorius* L.
(Bhatia and Singh 1939, Delhi, infesting flowers; Narayanan and Batra 1960).

Centaurea americana Nutt.

(Menon, Kapoor and Mahto 1968, Delhi, infesting flowers; I found it infesting these flowers at Srinagar, Kashmir. This also hap-

pens to be the first report of this fruitfly from Kashmir).

Wild host: Unknown

Isoconia bifaria Munro

Cultivated host: Unknown

Wild host: *Barleria* sp.

(Munro 1947, at Coimbatore, infesting pods).

Stylia sororcula (Wied.)

Cultivated host: *Dahlia* sp. (*D. Pinnata* Cav.?)

Coreopsis drummondi Torr. and Gray

C. grandiflora Hogg

(I bred this fruitfly from the above flowers at Aligarh, U.P.)

Wild host: *Coreopsis* sp.

Bidens sp., and other Compositae.

(Hardy 1964, Nepal, infesting seeds).

Tephritis cardualis Hardy

Cultivated host: Unknown

Wild host: *Carduus edelbergii* (= *C. nutans*) (Hardy 1974, Swat Distt., N.W.F.P., Pakistan, breeding in flower heads).

Tephritis tribulicola Senior-White

Cultivated host: Unknown

Wild host: Thistle

(Senior-White 1922, Shillong and Mawphlang, Assam).

Trupanea amoena (Frfld.)

Cultivated host: *Tagetes erectus* L.

Chrysanthemum indicus L.

(Trehan 1946, at Lyallpur, Pakistan, infesting flowers).

Wild host: *Veronia cinarea* Less.

(Tehran 1946, at Pusa, Bihar, infesting flowers)

Trupanea stellata Fuessly

Cultivated host: *Calendula officinalis* L.

(Nirula 1942, at Delhi, infesting flowers).

Wild host: Unknown

Host plant — Fruit fly list

Host	*Species*
ACANTHACEAE	
Barleria sp.	*Isoconia bifaria* Munro
BAMBUSEAE	
Bambusa burmanica Gamble	*Chaetellipsis paradoxa* Bezzi
B. vulgaris Schrad.	*Chelyophora striata* (Froggatt)
Bamboo	*Chelyophora ceratitina* (Bezzi)
	Phaeospilodes bambusae Hering
Dendrocalamus giganteus Munro	*Ceratitis* sp.
	Chelyophora striata (Froggatt)
D. strictus Nees	*Chelyophora ceratitina* (Bezzi)
	Chelyophora striata (Froggatt)

COMPOSITAE	
Bidens sp.	*Stylia sororcula* (Wied.)
Calendula officinalis L.	*Trupanea stellata* Fuessly
Carduus edelbergii (= *C. nutans* L.)	*Tephritis cardualis* Hardy
Carthamus tinctorius L.	*Acanthiophilus helianthi* Rossi
Centaurea americana Nutt.	—do—
	Craspedoxantha octopunctata Bezzi
Chrysanthemum indicus L.	*Trupanea amoena* (Frfld.)
Coreopsis drummondi Torr. & Gray	*Stylia sororcula* (Wied.)
C. grandiflora Hogg	—do—
Coreopsis sp.	—do—
Dahlia sp. (*D. pinnata* Cav.?)	—do—
Eupatorium adenophorum Sprengel	*Procecidochares utilis* Stone
Gonicaulon glabrum Cass.	*Craspedoxantha octopunctata* Bezzi
Tagetes erectus L.	*Trupanea amoena* (Frfld.)
Veronia cinarea Less.	—do—
CUCURBITAE	
Citrullus vulgaris Schrad.	*Myiopardalis pardalina* (Bigot)
Cucumis melo L.	—do—
C. sativus L.	—do—
C. trigonus Roxb.	—do—
Cucurbita maxima Duch.	—do—
C. pepo L.	—do—
LEGUMINOSEAE	
Cassia fistula L.	*Rhacochlaena cassiae* Munro
LORANTHACEAE	
Loranthus longiflorus Desv.	*Ceratitella asiatica* Hardy
MORACEAE	
Morus sp.	*Anoplomus flexosus* Bezzi
RHAMNACEAE	
Zizyphus jujuba Lam. (= *Z. mauritiana* Lam.)	*Carpomyia vesuviana* Costa
Z. nummularia W. & A. (= *Z. rotundifolia* Lam.) (= *Z. microphylla* Roxb.)	—do—

Z. vulgaris Lam. (= *Z. sativa* Gaertn.) (= *Z. jujuba* Mill.)	*Carpomyia vesuviana* Costa
ROSACEAE	
Prunus persica Stokes	*Ceratitis capitata* (Wied.)
URTICACEAE	
Ficus sp.	*Gastrozona melanista* Bezzi

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OBSERVATIONS ON THE LENGTH-WEIGHT RELATIONSHIP OF THE FISH *RASBORA DANICONIUS* (HAM.-BUCH.)[1]

V. Y. THAKRE AND S. S. BAPAT[2]

(*With two text-figures*)

The present paper deals with the study of length-weight relationship in a cyprinid fish, *Rasbora daniconius*. The equations expressing this relationship in both the sexes of the adult fish are further studied to verify cube relationship (Le Cren 1951) between these two measurements. To see whether the two regression equations obtained here, one in the case of each of the females and the males, differ significantly from each other, the test of analysis of covariance is performed.

INTRODUCTION

Since growth generally contributes to the increase of both, length and weight of a fish, the length-weight relationship is an interesting aspect of study to establish the statistical relationship between these two measurements. This relationship was expressed by earlier workers by the cubic formula, $W = aL^3$, wherein it is suggested that the weight (W) of the fish is equal to the product of the cube of the length (L) and a constant (a). Crozier and Hecht (1913) found this cubic law inadequate to explain the length-weight relationship in fishes. The general assumption that the weight of the fish varies as the cube of its length did not show accuracy in the empirical results. Allen (1938) supported the cube law in case of fish which maintain the same shape. Therefore to be able to explain the varying power value of L in case of fish available in nature in general, many workers adopted the parabolic equation of the form, $W = aL^b$. Hile (1936) and Martin (1949) in this connection found that the power values of b usually varied between 2.5 and 4 in different fishes. Le Cren (1951) revealed that as retaining either of the shape of the body outline, or of the constant specific gravity of the tissues is almost an impossible event, the relationship may depart from cube law proposed for an ideal fish. Hence he admitted the use of b power formula and also pointed out the superiority of b power formula over cubic formula for the reason that the former besides being useful in finding out weight and length measurements may also be used for indicating the condition factor or ponderal index, spawning season and the taxonomic differences and events in the life history, such as, metamorphosis and the onset of maturity.

MATERIALS AND METHODS

Adult specimens, freshly collected from river Kham, near Aurangabad were brought to the laboratory, cleaned under tap water and immediately after removing the body moisture with the help of blotting paper, their weight and total length measurements were noted ac-

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curately. The sex was recorded by opening the abdomen. Thus 3085 adult specimens, comprising 2152 females in the range of 36-160 mm and 933 males in the range of 36-123 mm were considered in this study. The indeterminants below 36 mm. being very rare in catch, could not be obtained regularly and sufficiently and therefore, they were not included in the present study. The length-weight data of females and the males were then analysed separately and grouped into various length groups of 10 mm size interval. The mean values of length and weight representing each length group were then calculated in respect of the number of specimens in each length group. These mean values were used in the calculation of length-weight relationship.

The general parabolic form of equation, $W = aL^b$ was used to show the statistical relationship between length and weight. Since the weight-length ratio is a power relationship, logarithms were used, so that the exponential relation could be expressed by a linear equation:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

which corresponds to the regression line equation,

$$Y = a' + bX.$$

where, $Y = \text{Log } W$, $X = \text{Log } L$ — are the two variates and

$a' = \text{Log } a$ and b — are the constants.

Thus, the above equation with weight (W) and length (L) in logarithmic form can be treated as the equation of regression line, $Y = a' + bX$, wherein the values of constants, a' and b are to be determined. The following equations have been used for this purpose.

$$b = \frac{\Sigma xy}{\Sigma x^2} \text{ and } a' = \frac{\Sigma Y - b \ \Sigma X}{n}$$

where X and y are the logarithmic forms of length and weight respectively and n, the number of the group samples, *x and y* are the deviation values of X and Y respectively from their mean i.e. $X - \overline{X} = x$ and $Y = \overline{Y} = y$.

The calculated value of Y for each size group was then estimated by substituting the values of X and the constants a′ and b in the equation, $y = a' + bX$. The equation, $W = aL^b$, showing exponential relationship between length and weight was expressed, in females and males, separately. W was calculated for every mean total length (L) and the relation-

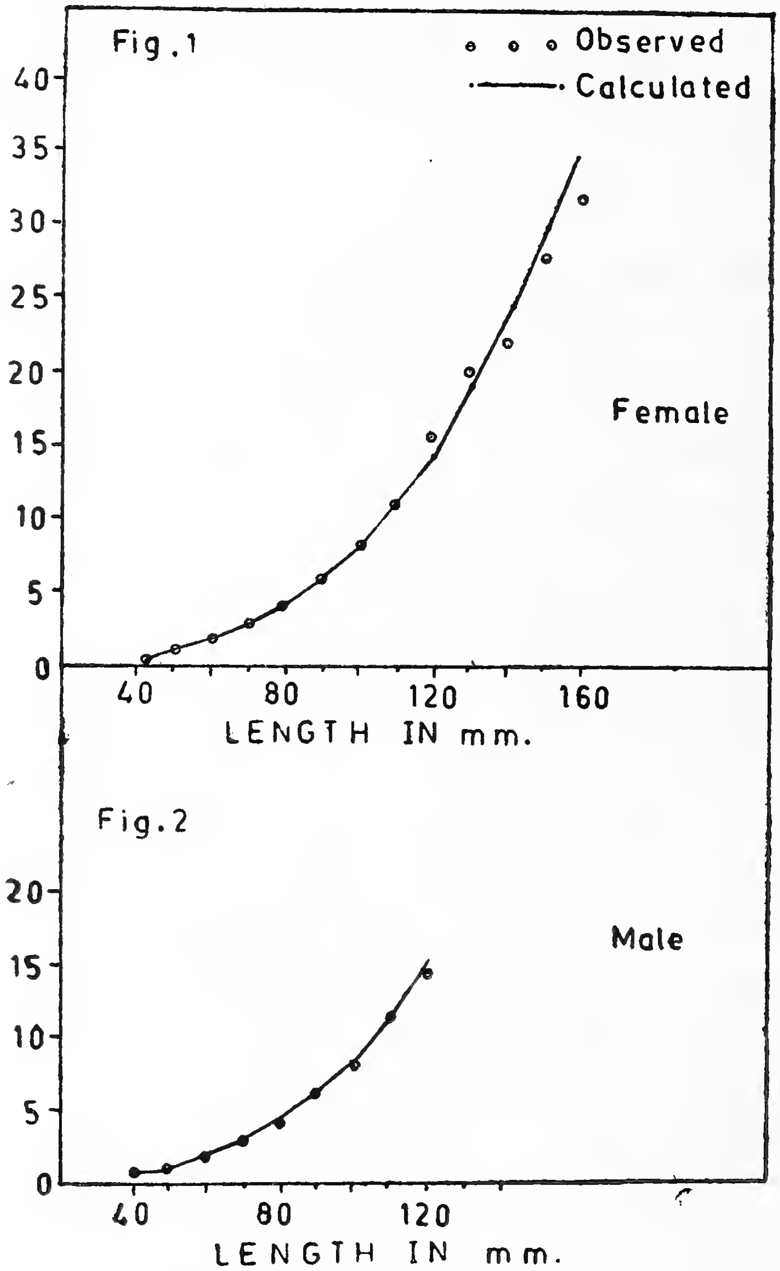

Fig. 1. Graph showing length-weight relationship in female *R. daniconius*.

Fig. 2. Graph showing length-weight relationship in male *R. daniconius*.

ship between these two measurements is shown graphically for females and males in Figs. 1 and 2 respectively.

Results

The equations showing the relationship between length and weight in females and males are expressed as below:

Females: $W = 0.003980\ L^{3.1524}$

Males : $W = 0.003007\ L^{3.2190}$

and in the linear form of regression line equation as:

Females: $\text{Log } W = -2.4002 + 3.1524 \text{ Log } L$

Males : $\text{Log } W = -2.5218 + 3.1290 \text{ Log } L$

The data of length-weight relationship for females and males were analysed to test whether the two regression equations obtained above differed significantly from each other. The test was performed by the method of analysis of covariance (Snedecor 1961). Particulars of the analysis of covariance are given in Table 1. It is evident therefrom that the length-weight relationships both in females and males do not differ significantly at 5% and 1% level of significance.

Table 1

Comparison of the regression lines of the length-weight relationship in *R. daniconius*

test of significance by analysis of covariance

Sr. No.	Source of variation	D.F.	Σx^2	Σy^2	Σxy	Regression coefficient	Deviation from regression D.F.	S.S.	M.S.	Calculated F	Tabulated F	Remarks
1.	Females	12	0.4022	4.1316	1.2679	3.1524	11	0.1347				
2.	Males	8	0.1982	2.0577	0.6380	3.2190	7	0.0040				
3.	Deviation from individual regressions within sexes.						18	0.1387	0.0077	15.4	5% in between 245.9 (15 d.f.) and 248.0 (20 d.f.)	Females and males do not differ significantly
4.	Differences between regressions.						1	0.0005	0.0005		1% in between 6157 (15 d.f.) and 6209 (20 d.f.)	
5.	Deviation from total regression.	20	0.6004	6.1893	1.9059	3.1744	19	0.1392				

The extent of association between X and Y values also was tested by estimating the coefficient of correlation (r). For females the r was found to be 0.9836 (d. f. 12, r, 5% = 0.532 and r, 1% = 0.661) and for males 0.9991 (d. f. 8, r, 5% = 0.632 and r, 1% = 0.765). This showed that in both the sexes r was perfectly significant indicating a good asso-

ciation between the two measurements of length and weight.

The regression coefficient, b is 3.1524 in case of females and 3.2190 in case of males. Both the values of b are slightly greater than 3 and thus closely, if not perfectly, support the cube law. With a view to see, whether the regression coefficient b differed from 3, the 't' test (Ostle 1966) was performed. In females 't' was found to be 2.9308 (d. f. 11, t. 5% = 2.201) and in males 5.2771 (d. f. 7, 't', 5% = 2.365). The 't' test revealed significant difference of b from 3 at 5% level of significance in both the sexes, thus showing thereby 'b' slightly higher than 3.

The calculated value of W for every mean L has been graphically depicted in Figs. 1 and 2 in case of females and males respectively. Both the graphs are curvilinear. The observed values of weight for different size groups, shown as encircled dots, are seen to lie close to the respective calculated values of weight.

As can be seen from Figs. 1 and 2 both females and males upto 80 mm in length increase in weight at a lesser rate than in the subsequent size groups. This may be attributed to the slow gonadal growth generally found in the first time breeders.

Discussion

The present results coincide with the observations of several workers. Prabhu (1955) worked on length-weight relationship of *Trichiurus haumela* and inferred that the weight increase in proportion to its length showed a normal pattern (the value of b was noted as 3.0819). Bhatnagar (1963) worked on *Puntius kolus* and found that the values of 'b' were slightly higher than 3 in males and females but not so in juveniles. Misu (1964) and Narasimhan (1970) worked on the length-weight relationship of *Trichiurus lepturus*, the former from East China Seas and Yellow Sea and the latter from Kakinada, India, and showed that there was a deviation from the so called cube law and weight of the fish increased at a rate higher than the cube of the length. Chatterji *et al.* (1977) worked on the length-weight relationship of a carp, *Labeo bata* and showed that the fish did not strictly follow the cube law and the weight increased at a rate more than the cube of the length.

Acknowledgements

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INFLUENCE OF ATMOSPHERIC TEMPERATURE AND HUMIDITY ON THE VARIATIONS IN SEASONAL ABUNDANCE AND PHENOLOGY OF *MICRONECTA STRIATA* FIEBER[1]

T. C. Banerjee, A. S. Mondal and
T. K. Nayek[2]

(With seven text-figures)

Catches of *Micronecta striata* F. in a light trap surrounding the Crop Research Farm were continually obtained at different seasons over twenty-one months. Numerical abundance during the different seasons varied consistently, leading to the occurrence of well-defined peaks in September 1978, and March, June and October 1979. The data were compared with the prevailing conditions of atmospheric temperature and humidity. Observed variations in local abundance and activity were fairly associated with the seasonal changes in both the parameters. Annual simple correlations were significantly negative ($P \leqslant 0.05$) with maximum temperature and indifferent with minimum temperature. More of the variations (59.01%) in the activity of *M. striata* were related to the changes in maximum relative humidity ($P \leqslant 0.01$) than that of the minimum one. Variance analysis suggested that a little alteration in the moisture content of the air during night might induce considerable changes in the activity of the species population.

Introduction

Seasonal variations in distribution and abundance of the tropical insects are largely conditioned by variations in the environmental parameters, particularly the weather that produces profound influence on the phenology of the species concerned (Dobzhansky and Pavan 1950, Andrewartha and Birch 1954, Williams 1961, Owen 1969, Gibbs and Leston 1970, Bigger 1976, Wolda 1978b). In such areas with six pronounced seasons, as most of eastern India, the numerical strength of insects decreases during summer and winter but, it increases during autumn and spring when the ecological conditions become favourable (Banerjee and Choudhuri 1980).

The local status and phenology of *Micronecta striata* Fieber in relation to tropical weather conditions are comparatively less known. This paper, attempts to consider the local abundance and phenology of the insect species, by means of a light trap, in relation to the tropical conditions of atmospheric temperature and humidity.

Material and Methods

The material of this investigation comprised the adults of a phototropic nocturnal insect, *M. striata* Fieber (Hemiptera: Corixidae) which was collected continually over twenty-one months (April 1978-December 1979) by a light trap in the Crop Research Farm, Uni-

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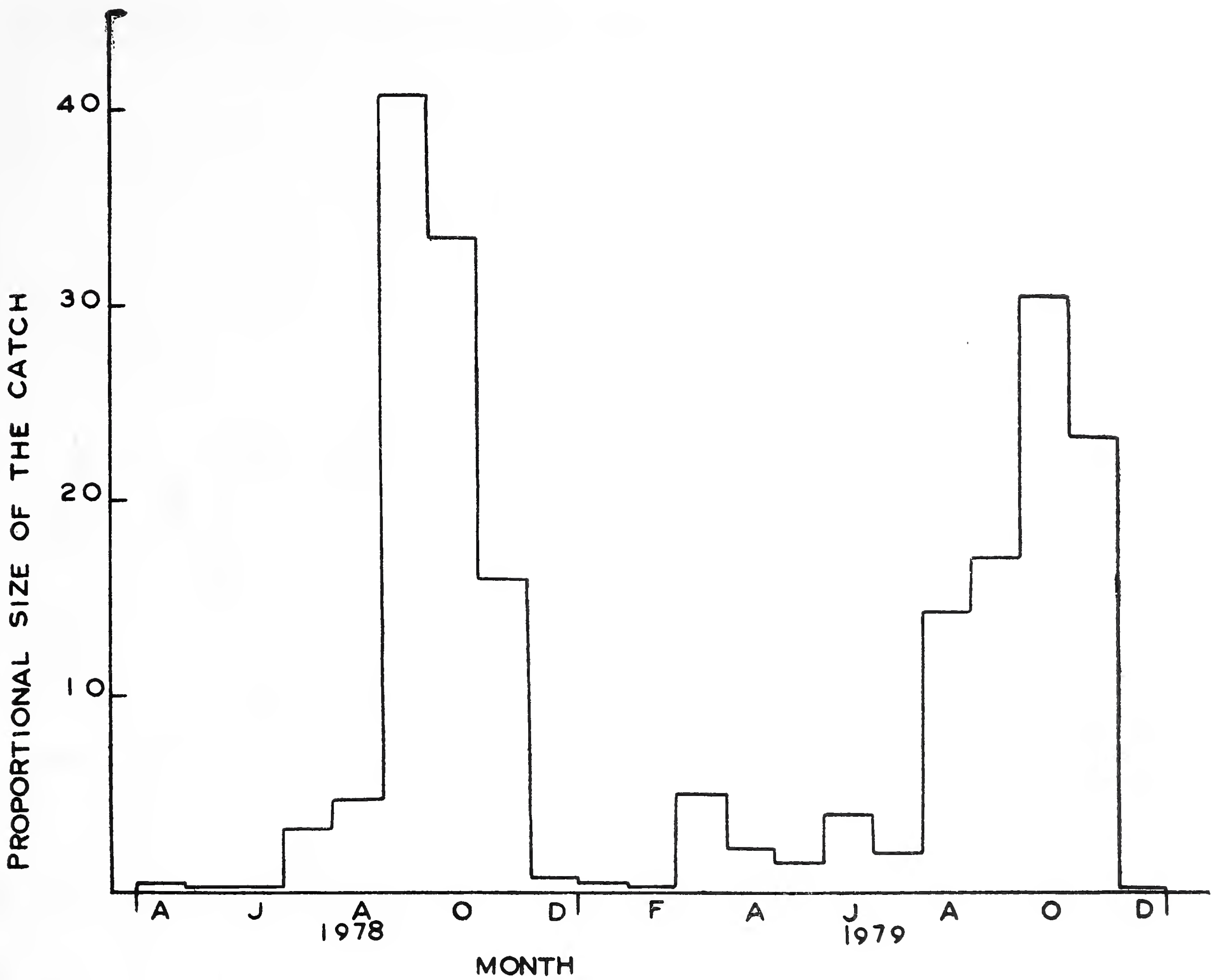

Fig. 1. Seasonal variations in distribution and abundance of the captures of *M. striata* in a light trap.

versity of Burdwan (23°16′N and 87°54′E). The insect is widely distributed and one of the most abundant species in the group. It lives submerged in water clinging with its hind legs to various objects (Popham 1943, Pruthi 1969) but swarms in the air for various biological activities.

Trapping covered the time between half-an-hour before sunset and half-an-hour after sunrise everyday. Certain unavoidable circumstances arising out of power failure, mechanical defects, etc., however, caused interruptions in the continuous trapping for 8 nights in 1978 and 14 nights in 1979. The numerical strength of the catch (i.e. local abundance X activity) differed from night to night probably due to the prevalence of variable weather conditions which produced occasionally considerably large or small collections. The five-day running mean was adopted to avoid swamping effects produced by the excess captures on the small ones.

The data on the seasonal variations in abundance and activity of the species population, as measured by the light trap catches, were maintained in the laboratory in the following morning and expressed as mean log catch ± 1 S.E. per night (Williams 1937, Beall 1938). This logarithmic transformation of the nightly capture made the assumed linearity more plausible since each transformation reduced the range of the variable concerned. In practice, one was added before taking logarithm of each of the dependent variable (i.e. log n+1) to mitigate any zero catch.

The influencing atmospheric environmental parameters considered for the study were the maximum temperature and minimum relative humidity of the day preceding the night of capture, and the minimum temperature and maximum relative humidity on the night of capture. These were taken by the Meteorological Branch at Burdwan under the Directo-

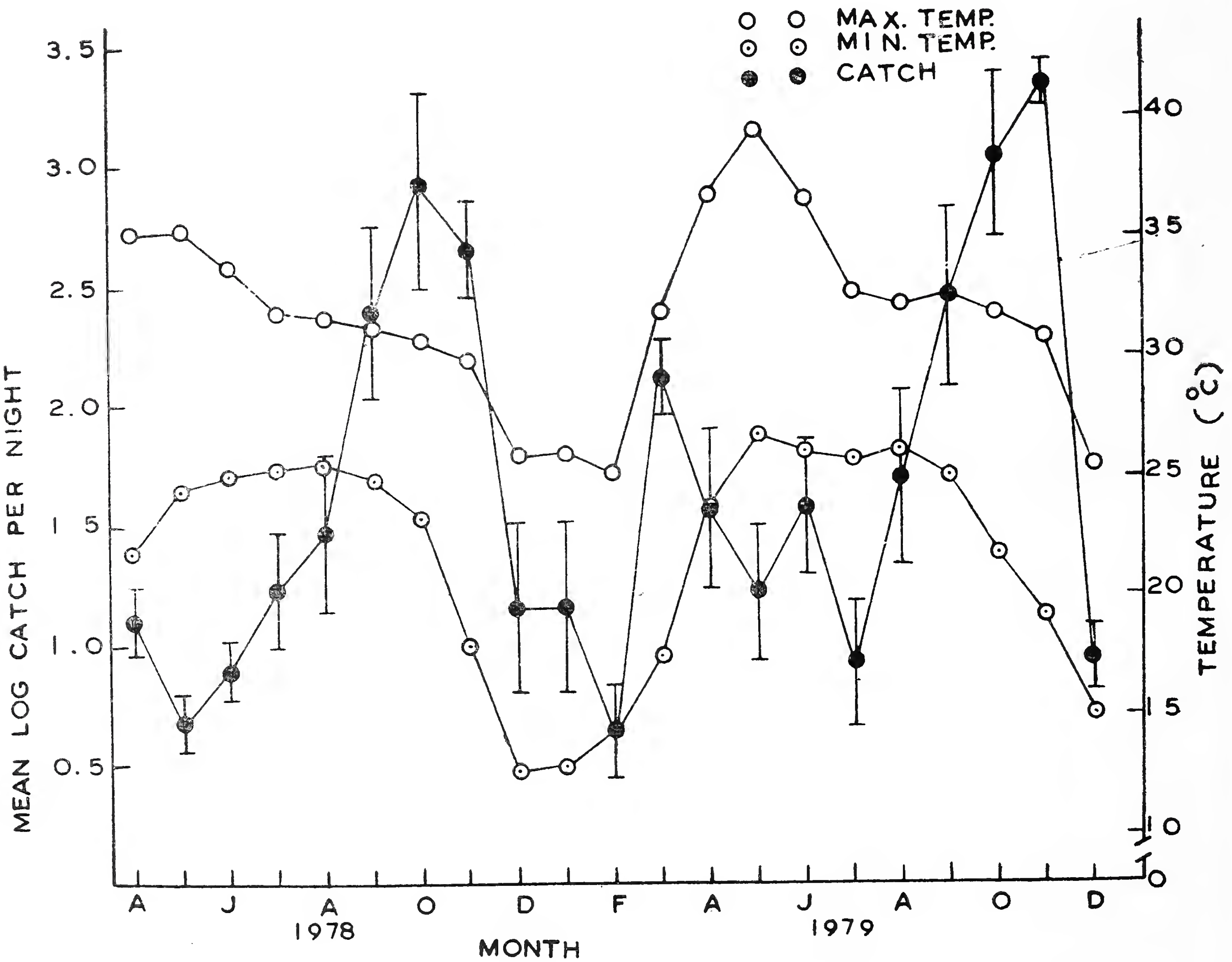

Fig. 2. Seasonal changes in abundance, as mean log catch per night, of *M. striata* against the corresponding changes in atmospheric maximum and minimum temperature (Vertical lines represent one standard error on either sides of the mean).

rate of Agriculture, Government of West Bengal, which operated a constantly recording thermo-hygrograph.

The correlation and regression co-efficients were worked out to enquire into the relations between the dependent and independent variables (Bailey 1959). The annual 'b' values were further employed to forecast the average amount of change in each weather factor that would precisely be required for a unit change in the dependent variable. Since the interpretation of such simple relationship was complicated by simultaneous relations existing within the matrix, the analysis of variance was resorted to for examining the extent of contribution made by each of the influencing parameters, so as to account for the total sum of squares of the deviations in the dependent variables.

Results

Variations in seasonal abundance:

It was observed that a collection of 745211 adult individuals of *M. striata* was continually caught over twenty-one months. The composition of the captures differed from 2 47 009 in 1978 to 4 98 202 in 1979. Figure 1 presents the variations in the local abundance of the insect, as indicated by the light trap captures, for each month sampled. The proportional capture shows the increase during September-October (40.7%-33.4%) in 1978 and September-November (16.9%-30.6%) in 1979.

Despite such increases, the numerical strength of the species population varied consistently, leading to the occurrence of well-defined peaks in September 1978, and March, June and October 1979. These peaks probably represent the abundance contributed by the cycling of life-processes of the species population in the locality, and increased local activity induced by the prevailing circumstances in which the catches occurred during those months.

Variations in activity in relation to temperature:

The variations in the seasonal abundance, as mean log catch per night, in relation to recorded changes in temperature parameters, have been presented in figure 2. The swamping effects, produced by occasional excess captures resulting in substantial change in the proportion on three and two nights in September 1978 and October 1979, respectively, were reduced by the treatment of running logarithmic mean. It would, thus, be noticed that the peaks were shifted from September to October 1978 and October to November 1979 (cf. Fig. 1).

The larger values in the curve during October 1978, and March, June and November 1979 indicated associations between the activity of the insect species resulting in higher captures and the respective maxima and minima of take-off temperature that ranged from 30.86°C to 23.68°C, 31.98°C to 18.64°C, 36.56°C to 25.91°C and 30.86°C to 19.22°C. In spite of such associations, the seasonal variations in phenology ought not to be considered as the only contribution of temperature parameters. Still, much of the variations in the occurrence of such events might be ascribed to the changing influence of ambient temperature conditions of the plots during certain months.

The correlation and regression coefficients between the temperature parameters and the captures of *M. striata* have been presented in table 1. The 'r' values with maximum temperature were significantly positive in August, September and December 1978, and in February and December 1979. Similarly, the 'r' values with minimum temperature were significantly positive in December 1978, and Febru-

ary, September and December 1979; and negative in July 1979. Besides, the average 'r' value for 1978 was significantly negative ($P \leqslant 0.05$) with maximum temperature; whereas, two years' average correlations were insignificantly positive with regard to both the parameters.

The linear relationship between the captures of the insect and the temperature parameters

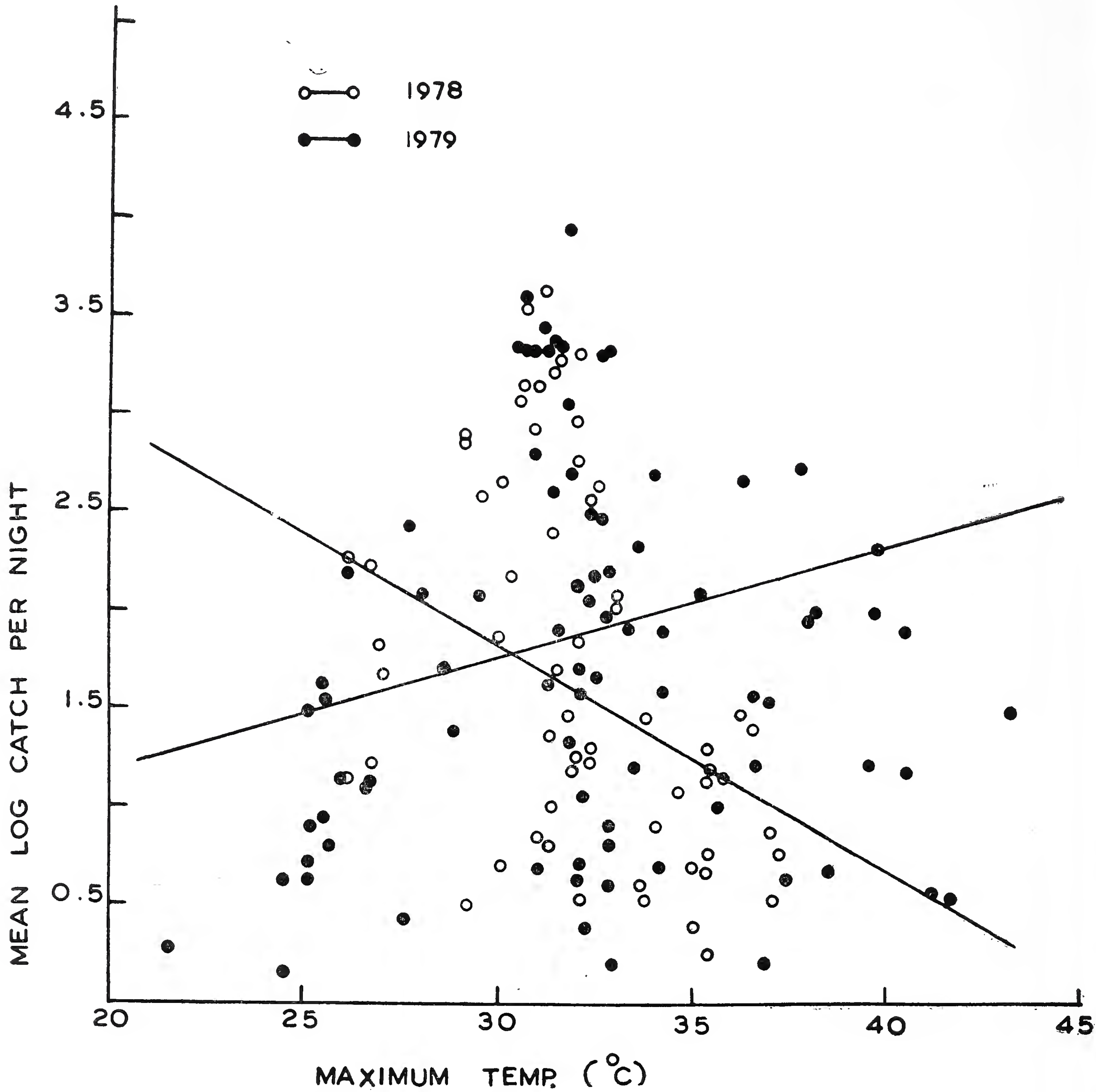

Fig. 3. Scatter diagram with regression lines showing relationship between the captures of *M. striata* and atmospheric maximum temperature (for 1978, Y = 5.2833-0.115 x and 1979, Y = 0.5936 + 0.0355 x).

may also be shown graphically in the form of scatter diagrams (Figs. 3 and 4). The slope of the fitted lines in each diagram indicated respective regression constants for maximum temperature (—0.115 for 1978 and 0.0355 for 1979) and minimum temperature (—0.012

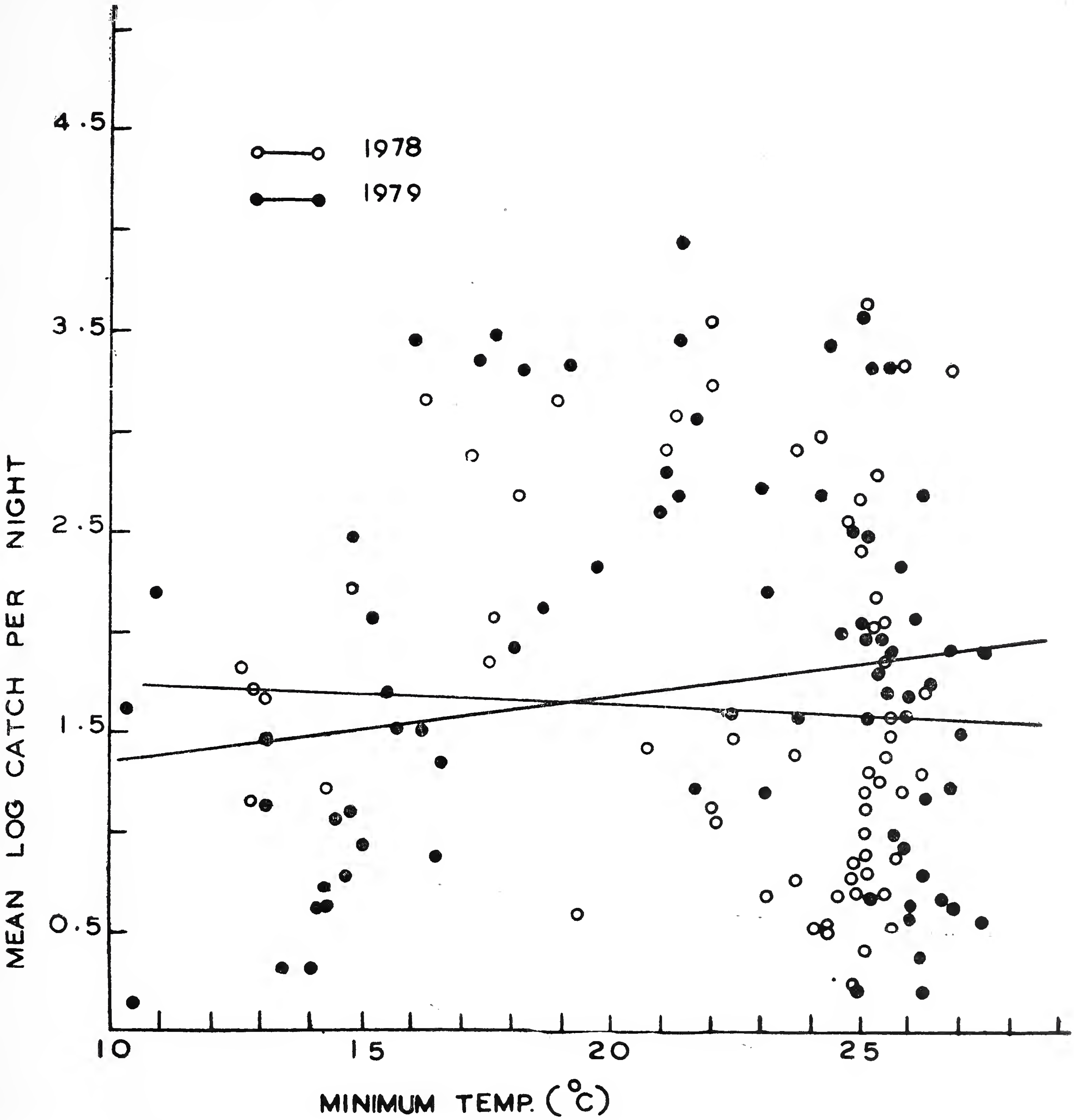

Fig. 4. Scatter diagram with regression lines showing relationship between the captures of *M. striata* and atmospheric minimum temperature (for 1978, Y = 1.8878 — 0.012 x and 1979, Y = 1.0778 + 0.0304 x).

TABLE 1

CORRELATION AND REGRESSION COEFFICIENTS BETWEEN THE CAPTURES (LOG N+1) OF *M. striata* AND THE ATMOSPHERIC MAXIMUM AND MINIMUM TEMPERATURES

	Maximum temperature (°C)				Minimum temperature (°C)			
	1978		1979		1978		1979	
	Corr.	Reg.	Corr.	Reg.	Corr.	Reg.	Corr.	Reg.
January	—	—	0.5377	0.4593	—	—	−0.1658	−0.0560
February	—	—	0.7191*	0.1327	—	—	0.9404***	0.3829
March	—	—	0.1395	0.0183	—	—	−0.0281	−0.0040
April	0.1278	0.0314	0.3869	0.2014	0.3160	0.0684	−0.1036	−0.0660
May	0.1942	0.0467	0.1762	0.0867	0.3010	0.1067	−0.3614	−0.4115
June	−0.3919	−0.0711	−0.6261	−0.1018	−0.1577	−0.2298	−0.4885	−0.4033
July	0.6983	0.6193	0.4875	0.4386	0.2237	0.3972	−0.7497*	1.1175
August	0.7091*	1.3989	0.6551	0.7598	−0.0464	−0.0761	−0.1179	−0.3288
September	0.8638**	0.6434	0.0420	0.0515	0.4873	0.7780	0.9632***	1.5825
October	0.6968	1.3882	−0.5818	−0.6406	−0.2030	−0.1007	−0.5670	−0.4719
November	0.288	0.2151	−0.0155	−0.0110	−0.1855	−0.0626	−0.0056	−0.005
December	0.9071**	0.7552	0.8601**	0.5376	0.7893*	0.4649	0.7420*	0.5496
Annual	−0.4062*	−0.1150	0.1890	0.0355	−0.0632	−0.0120	0.1777	0.0304
Average of 1978 and 1979; Corr. = 0.0061 Reg. = 0.0013					Corr. = 0.0787 Reg. = 0.014			

Significant differences are indicated by *(P ⩽ 0.05). **(P ⩽ 0.01) or *** (P ⩽ 0.001).

TABLE 2

CORRELATION AND REGRESSION COEFFICIENTS BETWEEN THE CAPTURES (LOG N+1) OF *M. striata* AND THE ATMOSPHERIC MAXIMUM AND MINIMUM HUMIDITY PARAMETERS

	Maximum Humidity (%)				Minimum Humidity (%)			
	1978		1979		1978		1979	
	Corr.	Reg.	Corr.	Reg.	Corr.	Reg.	Corr.	Reg.
January	—	—	−0.5363	−0.3825	—	—	−0.3640	−0.0287
February	—	—	−0.0803	−0.0164	—	—	−0.7379*	−0.0320
March	—	—	−0.7354*	−0.0837	—	—	0.0236	0.0009
April	−0.3924	−0.0714	−0.1373	−0.0411	−0.2665	−0.0095	−0.3558	−0.0607
May	−0.3131	−0.0573	0.3567	0.0972	−0.4411	−0.0267	0.8498**	0.2123
June	0.271	0.0149	0.8084*	0.0689	0.4972	0.0154	0.5936	0.0301
July	0.3086	0.1332	−0.2733	−0.0692	−0.8891**	−0.2083	−0.0460	−0.0460
August	−0.5684	−0.4599	−0.1663	−0.1104	0.6098	0.1607	−0.5582	−0.1478
September	−0.8020*	−0.4985	−0.6791	−0.5115	−0.9864***	−0.1380	−0.4632	−0.4632
October	−0.5435	−0.2769	−0.9747***	−0.557	−0.7342*	−0.1011	0.0822	0.0233
November	0.7076*	0.1430	−0.7944*	−0.0664	−0.0339	−0.0016	−0.7443*	−0.0353
December	0.6872	0.3002	−0.3196	−0.0642	0.1084	0.0231	−0.6003	−0.0618
Annual	0.4781**	0.1871	0.0361	0.0105	0.3079	0.0160	−0.0622	−0.0038
Average of 1978 and 1979: Corr. = 0.1806 Reg. = 0.0579					Corr. = 0.1006 Reg. = 0.0057			

Significant differences are indicated by *(P ⩽0.05), **(P ⩽ 0.01) or ***(P ⩽ 0.001).

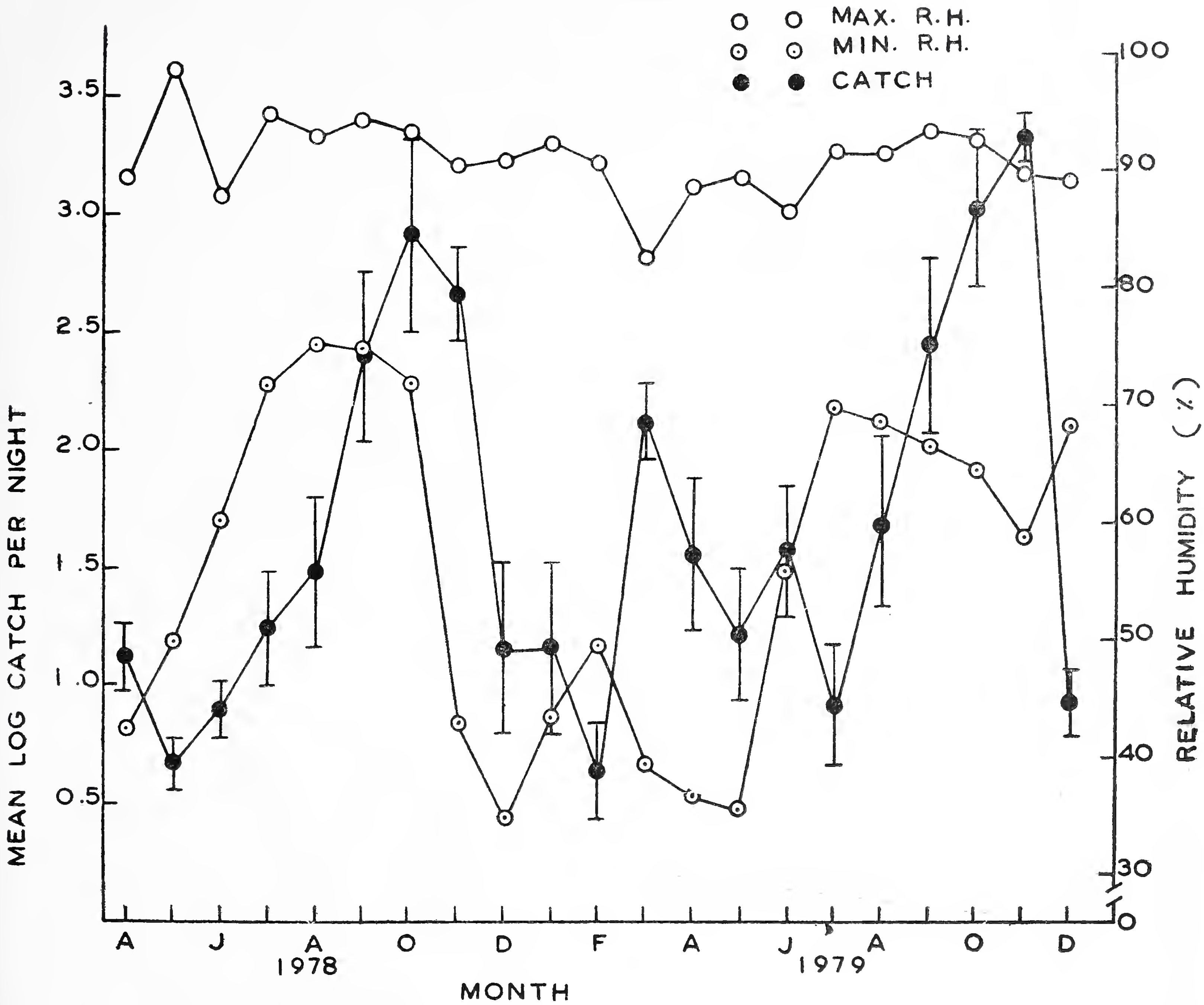

Fig. 5. Seasonal changes in abundance, as mean log catch per night, of *M. striata* against the corresponding changes in atmospheric maximum and minimum relative humidity (Vertical lines represent one standard error on either sides of the mean).

for 1978 and 0.0304 for 1979). The positive 'b' values for 1979 with both the parameters suggested that the average change of 8.5°C or 9.9°C in the respective atmospheric maximum and minimum temperatures would precisely be required for a unit change in the activity of the insect species.

Variations in activity in relation to relative humidity:

Figure 5 shows the seasonal changes in abundance of *M. striata* as mean log catch per night, in relation to corresponding changes in the moisture content of the air. It would be noted from the figure that the average mini-

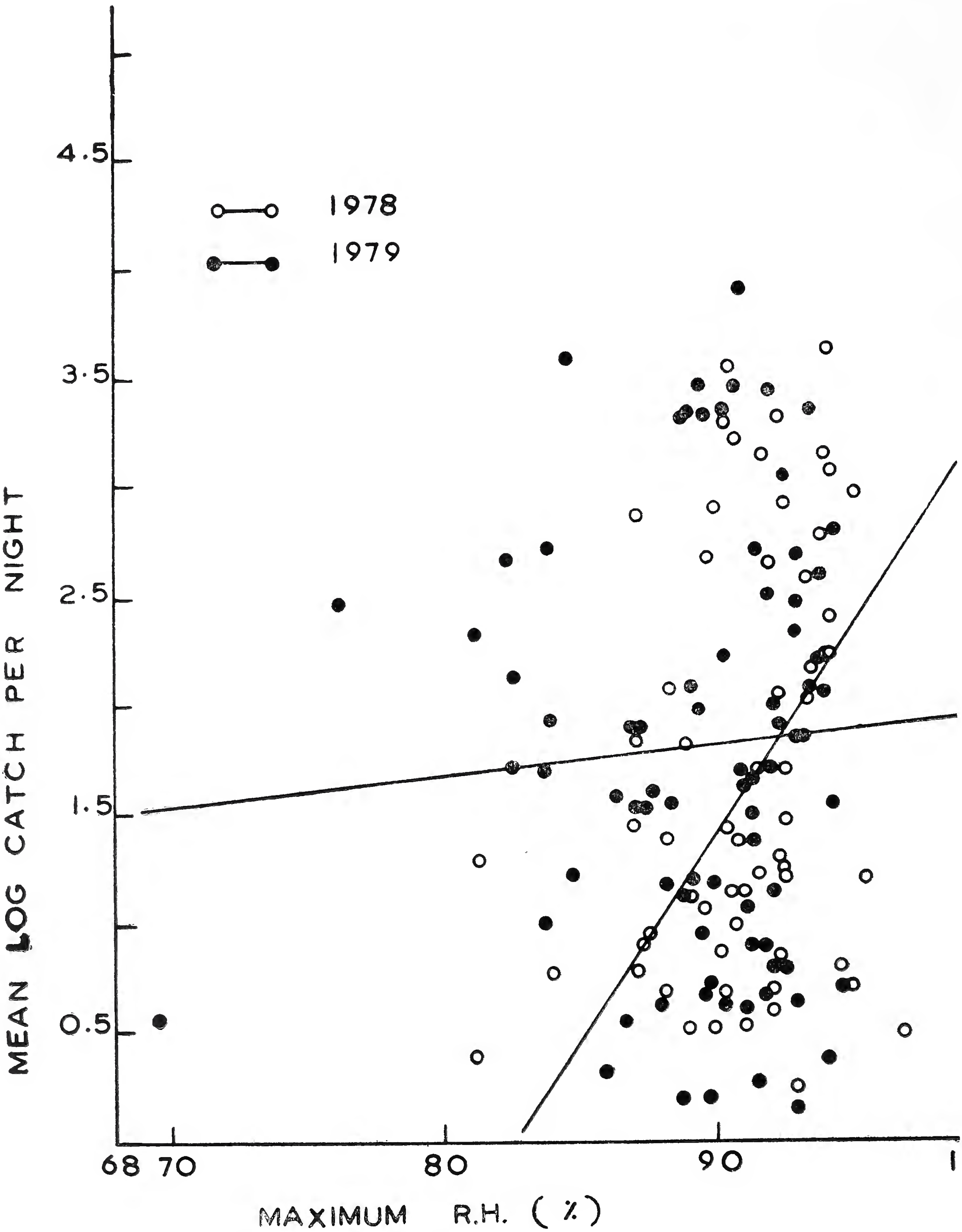

Fig. 6. Scatter diagram with regression lines showing relationship between the captures of *M. striata* and atmospheric maximum relative humidity (for 1978, Y = 0.1871 x − 15.419 and 1979, Y = 0.8717 + 0.0105 x).

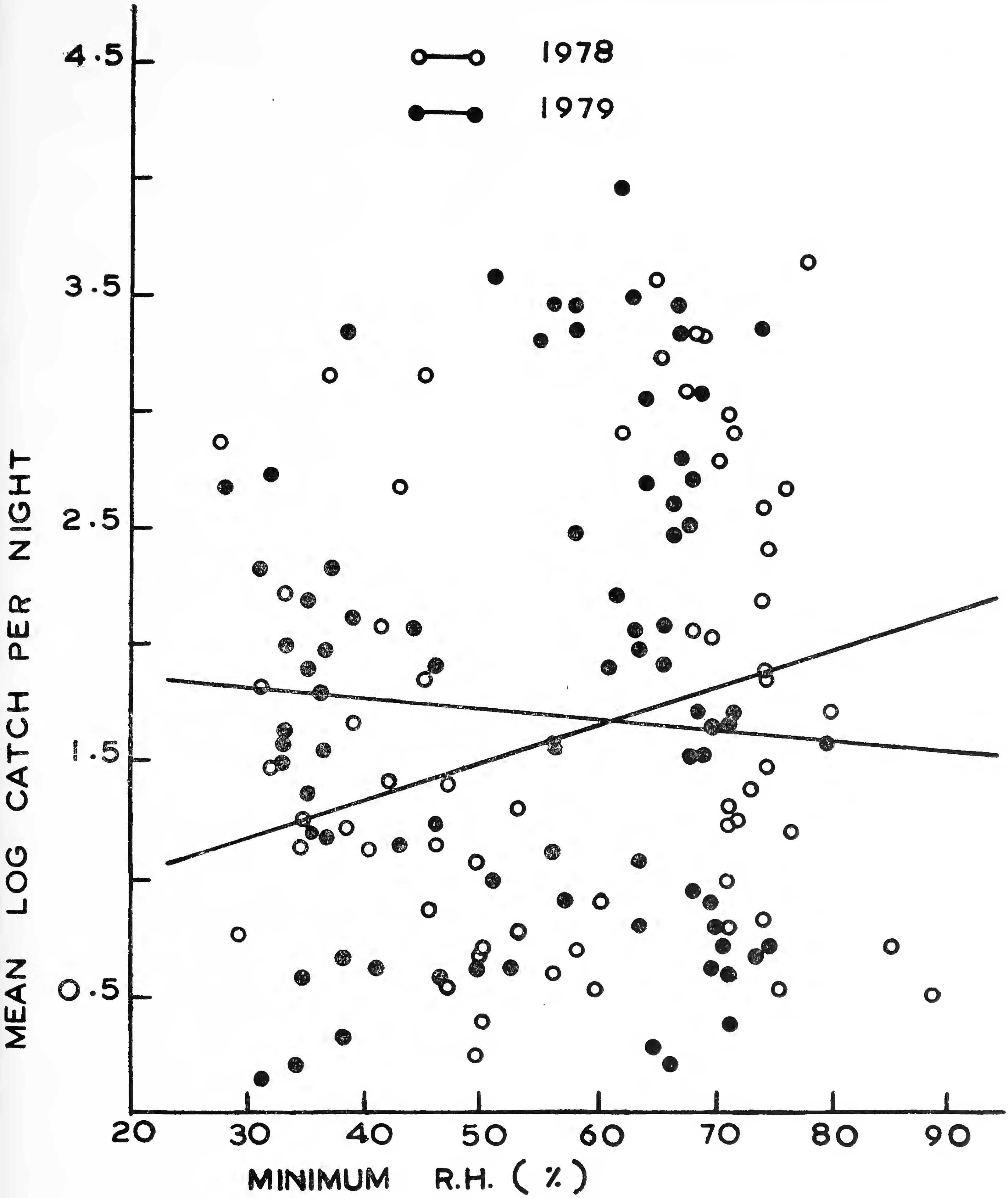

Fig. 7. Scatter diagram with regression lines showing relationship between the captures of *M. striata* and atmospheric minimum relative humidity (for 1978, $Y = 0.6903 + 0.016\ x$ and 1979, $Y = 1.9246 - 0.0038\ x$).

mum relative humidity fluctuated violently (34.52%-74.46%) in contrast with that of the maximum one (82.55%-94.26%). Even then, the increases in local activity and abundance of the insect species during October 1978, and March, June and November 1979 were associated with the respective maxima and minima of local humidity parameters ranging from 92.57 to 71.6%, 82.55 to 39.17%, 86.36 to 55.9% and 89.7 to 58.7%.

Simple correlations with the maximum relative humidity indicated that these were significantly positive in November 1978, and June 1979; and negative in September 1978, and March, October and November 1979 (Table 2). Similarly, the 'r' values with minimum relative humidity were significantly positive in May 1979; and negative in July, September and October 1978, and February and November 1979. Besides, the average 'r' value for 1978 was significantly positive ($P \leqslant 0.01$) with maximum relative humidity; whereas, two years' average correlations were insignificantly positive with regard to both the humidity parameters.

Figures 6 and 7 indicate through scatter diagrams the linear relationship between the captures of the insect species and the humidity parameters. The regression constants with the humidity parameters indicated that the average changes of 1.6% or 28.8% in the atmospheric maximum relative humidity during 1978 or 1979, respectively and 18.9% in the atmospheric minimum relative humidity during 1979, would precisely be required for a unit change in the activity of the species population.

It ought to be evident from the above that the change in the activity of *M. striata* was somewhat influenced by the seasonal changes in temperature and humidity conditions of the

TABLE 3

ANALYSIS OF VARIANCE OF THE CAPTURES (LOG N+1) OF *M. striata* AGAINST THE ENVIRONMENTAL PARAMETERS (TABLE VALUES AT 5% AND 1% POINTS ARE 4.35 AND 8.10, WITH $f_1 = 1$ AND $f_2 = 20$, RESPECTIVELY)

Sources of variation	Sum of squares	Degrees of freedom	Mean squares.	Variance ratio (F)
Regression of max. temp.	0.0177	1	0.0177	0.0396
Residual	13.5074	20	0.6749 = 98.8% or 0.2% explained	
Regression of min. temp.	1.7346	1	1.7346	
Residual	11.7905	20	0.5895 = 87.18% or 12.82% explained	2.942
Regression of max. rh.	7.98	1	7.98	
Residual	5.5451	20	0.2772 = 40.99% or 59.01% explained	28.7878
Regression of max. rh.	2.8509	1	2.8509	
Residual	10.6742	20	0.5337 = 78.93% or 21.07% explained	5.3417
Total	13.5251	21	—	—

air. From the analysis of variance (Table 3), it may also be observed that a larger portion (80.08%) of the variations in the insect's activity was ascribed to the humidity parameters, particularly to the maximum one (59.01%), than that of the temperature parameters. The unexplained portion of the variations is ascribable to some other factors, such as rainfall, wind, food, etc. which are excluded from this purview.

Discussion

No matter what abundance and activity the light trap catches reveal, much of the representation of these catches in this paper is speculative because variations in the capture result from changes in the level of local abundance, and from the nature and extent of local activity induced by the prevailing environment (Bowden and Gibbs 1973, Banerjee 1977). It is, therefore, thought particularly useful to study the phenology of the species population that gives rise to the variations in seasonal captures in relation to the climatic conditions of the place.

Notwithstanding the source population, one trap at a single location was used to record events that involved variations in local abundance and activity of the insect species. The numerical change in abundance of the insect species between different times, as reflected by the light trap samples for all the seasons of the insect's activity, suggest its range of selective preference to the optimum environmental conditions.

Seasonal fluctuations in abundance and activity of insects depend on biotic as well as on climatic factors. The periods of large catches of the insect during September, October and November were related in some way to the prevailing local conditions of temperature and humidity. Temperature differences showed negative or indifferent correlation with the observed variations in the activity. Much of the variations (59.01%) in activity of *M. striata* was associated with the changes in the maximum relative humidity content of the air even though both of the influencing humidity parameters were considered for this study. This suggests that the insect, which is primarily an aquatic one, depends more on the moisture content of the air during night for its activity than on any weather factor; and slight alteration in such a parameter may induce considerable change in the activity of the species population.

Acknowledgement

We are thankful to Prof. D. K. Choudhuri for providing facilities to one of us (ASM) to work in the department.

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FURTHER CONTRIBUTION TO THE FLORA OF BUXA FOREST DIVISION, JALPAIGURI DISTRICT (WEST BENGAL)[1]

J. K. SIKDAR[2] AND ROLLA S. RAO[3]

(*With a text-figure*)

The paper presents an enumeration of 500 taxa belonging to 109 families of Angiosperms. Of these 424 species of Dicotyledons are spread over 306 genera and 93 families and 76 species of Monocotyledons over 58 genera and 16 families. All the taxa recorded here may be considered as further additions to sedges and grasses by Chaudhuri (1959) and the species from Buxa Division given by Ghosh & Ghosh (1977). In this paper a small number of collections made earlier but not worked out and reported earlier from this Division, are added along with extensive collections by me (J. K. Sikdar) from Buxa Division in different seasons during the years 1974-77 while working out the 'Flora of Jalpaiguri District'. Topography and general features of Buxa Division (D), earlier work, with recent additions on new, interesting and little known species, for India, Eastern India and West Bengal are given under introduction.

In the systematic enumeration nomenclature, localities with reference to forest ranges and field numbers are given.

INTRODUCTION

Of the four Forest Divisions in Jalpaiguri District, Buxa Division (D) is situated at the eastern-most part, 26°16′-26°41′N and 89°26′-89°55′E, bounded by Assam state in the east, Coochbehar forest division (in Jalpaiguri District) in the West, Bhutan in the north and Coochbehar District in the South. The Forest Division is mostly a plain land with the exception of Buxaduar hills under the Buxaduar forest range (D5) with Sinchula (± 1917 m) as the highest point.

The continuous stretch of reserve forest of Buxa Division (D) is divided into 7 forest ranges namely Nimati (D1), Damanpur (D2), Rajabhatkhawa (D3), Jainti (D4), Buxaduar (D5), Raidak (D6) and somewhat isolated block Bholka (D7). The forest Divisional Office is now at Rajabhatkhawa, a few kilometers from Alipurduar town. The forests of the Division cover an area of about 420.98 sq. km., out of the total forest area of nearly 1087.5 sq. km. of Jalpaiguri District. Besides 'Sal' (*Shorea robusta*) timber, the most important industry in this Division is Tea plantation and production of 'tea' (*Camellia sinensis*) by 27 Tea estates. In Jalpaiguri District, Buxa Forest Division (D) is floristically rich and significant when compared to the other three forest divisions. With the Himalayan region as the northern boundary and the high rainfall zone of Assam along the eastern part, there is every possibility of extension of distribution and

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migration of interesting plant species to the district through Buxa Division (D). The Alipurduar-Buxa road also presents a picturesque view with 'Sal', 'Saj', 'Champ', 'Sida' and other trees growing high on both sides of the road. In the Buxa and Sinchula forest areas, varieties of Orchids and ferns grow well. Buxaduar hills offer a splendid view all round. Numerous rivers and streams intersect the extensive tracts of 'Sal' and other forests reaching up to the hills.

With its interesting topography and unique geology and vegetation, Buxaduar range (D5) forests harbour several interesting species. The forests of this Division can be divided into (1) Semi-evergreen forests, (2) Moist deciduous forests, (3) Dry deciduous forests, (4) 'Sal' forests (Plantations), (5) Grasslands and (6) Riverain forests, thus clarifying to some extent the various forest types as presented by Champion and Seth (1968).

The Forest Division is made up of alluvium with deposits of coarse-gravel near the hills on the north, sandy clay and sand along the course of rivers. The beds of Buxa hills consist of variegated slates, quartzites and dolomites.

The average annual rainfall is 3925.1 mm (154.33″) in the Division with a slight increase on the north-eastern part (towards Buxaduar hills).

The floristic account and notes on the plants of Buxa Forest Division (D) are quite limited. They are (1) Gamble's (1878) list with many tree species of undivided Jalpaiguri district, (2) Prain's Bengal Plants (1903) from North Bengal in general without any mention of Jalpaiguri district, (3) a list without precise localities by Cowan and Cowan (1929), (4) notes on sedges and grasses by Chaudhuri (1959), (5) a brief sketch on the vegetation of Jalpaiguri district, based on limited collections during 1962 from Rajabhatkhawa Forest Range (D3) of this Division and Apalchand Forest Range of Baikunthapur Forest Division by Mukerjee (1965) with an addition of a few orchids and ferns from Buxa Division (1972 a; 1972 b), (6) K. P. Biswas' Book (upto Ericaceae 1967) with a few species from Rajabhatkhawa (D3) and Buxaduar (D5), but without any precise localities and (7) a list of 145 species (collected by V. Narayanswamy and party in 1949 and mostly identified by them but not published) by Ghosh and Ghosh (1977). Subsequently during 1974-77, Sikdar under the guidance of Rolla Rao, carried out careful field studies systematically, covering forest Ranges of all the Forest Divisions of Jalpaiguri district as Research Scholar of the Botanical Survey of India and prepared a detailed flora of the district (Ph.D. thesis, 1980). While the major flora work is under preparation, Sikdar along with others published brief notes on whatever interesting plants of the Division and other neighbouring areas that have been scrutinised earlier. They are Sikdar (1976; 1979; 1981a; 1981b; 1982), Sikdar & Ghosh (1978; 1979; 1981a; 1981b), Sikdar & Maiti (1979; 1981a; 1981b) and Sikdar & Maji (1981). Besides, the other published notes on the plants of the Division are by Ghosh & Maiti (1978) and Krishna & Dutta (1979).

It is therefore evident that data on the plant resources of the Buxa Forest Division (D) is very meagre and hence an attempt is now being made to present a good account on the plants of the Forest Division with specific localities etc. together with a map and other details, purely based on the collections made by Sikdar during his field studies in 1974-77.

Several interesting taxa, not recorded earlier from (1) West Bengal, (2) Eastern India and even from (3) India, but collected from the Division and published by Sikdar as new records for those areas are included in this work

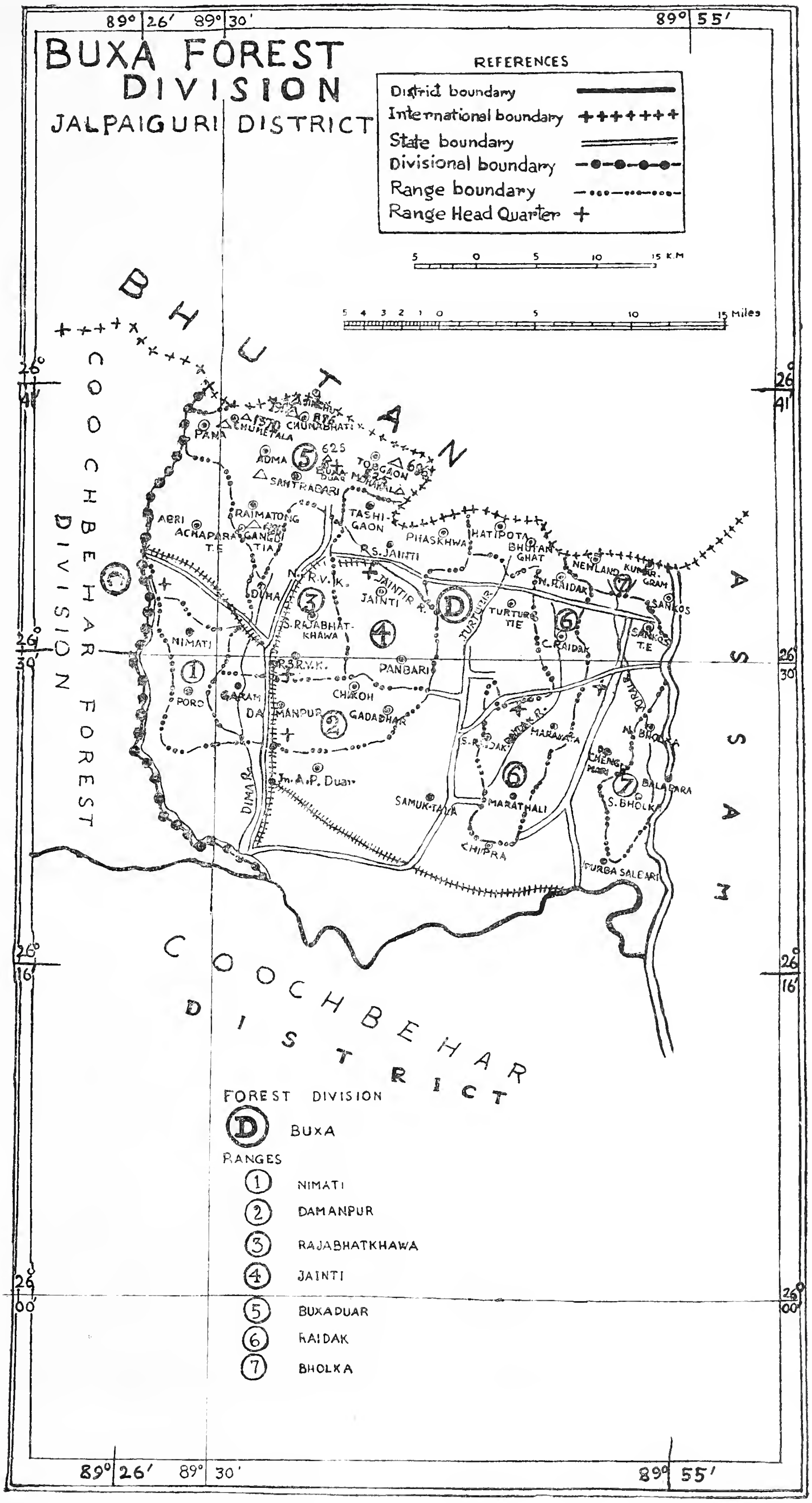
BUXA FOREST
DIVISION
JALPAIGURI DISTRICT
REFERENCES
District boundary
International boundary
State boundary
Divisional boundary
Range boundary
Range Head Quarter
BHUTAN
ASSAM
COOCHBEHAR DISTRICT
COOCHBEHAR FOREST DIVISION
FOREST DIVISION
BUXA
RANGES
NIMATI
DAMANPUR
RAJABHATKHAWA
JAINTI
BUXADUAR
RAIDAK
BHOLKA

Fig. 1.

with special markings as '*' for (1), '**' for (2), '***' for (3). The species described recently from the Division are marked with '+'. To mention a few interesting points of the geographical distribution of the so called endemics: *Amblyanthopsis bhotanica* (C. B. Clarke) Mez, an extremely rare and rather endemic species supposed to be confined to small patches in the sub-Himalayan foot hills of the tropical semi-evergreen zone of Bhutan with specific ecological habitat, is now collected after a span of nearly one and half centuries after its type collection in 1838, from very near to the type locality in the Buxaduar Forest Range (D5) practically on the Indo-Bhutanese border. Since type collection from Bhutan in 1837-38, *Senecio bhot* C. B. Clarke had been collected only twice from Bhutan. Then in 1975, one of us (Sikdar) collected the plant from Indian main land for the first time in Buxaduar forest Range (D5) of Jalpaiguri district. If it is assumed that *S. bhot* is a plant of recent introduction to the Duars, it indicates a gradual extension of its distribution southwards from subtropical Bhutan into the tropical sub-Himalayan foothills of North Bengal. *Acanthus carduaceous* Griffith is a scarcely known species once considered to be endemic to Bhutan but now known on the basis of recent collections by Sikdar to be gradually extending westwards towards Darjeeling district and also southwards along Jalpaiguri district (Buxa Division) of North Bengal. *Aganosma gracilis* Hook. f., an interesting rare species said to be confined to Sikkim, North Bengal (possibily Darjeeling district) and Meghalaya (Khasi hills), has now been collected from Buxaduar hills (D5) nearly fifty years after Cowan's report (1929). Sikdar (in press) made some critical observations on these little known species, *Amblyanthopsis bhotanica, Senecio bhot* and *Aganosma gracilis.*

Besides these, two new species have recently described from Buxa Division (D) i.e., *Dalbergia duarensis* by K. Thothathri (1972) on the basis of Heawood's collection of 1891 from Alipurduar (D3) and *Ophiorrhiza seshagiriana* by Sikdar & Maiti (1981) based on Sikdar's own collection from Buxaduar Forest Range (D5).

The present survey was conducted by one of us (J. K. Sikdar) during different seasons between the years 1974 to 1977 as a part of the project work "Flora of Jalpaiguri District" of Central National Herbarium, Howrah (CAL). Thus in the present paper 388 species (including varieties and subspecies) collected by Sikdar during 1974-77 and also a few by others which have not been worked and published so far, excluding however the species noted by Chaudhuri (1959) and Ghosh & Ghosh (1977) from Buxa Division (D) (to avoid repetition), are presented as additional data covering 500 taxa of Angiosperms distributed under 109 families (Dicotyledons 424 species under 306 genera and 93 families; Monocotyledons 76 species under 58 genera and 16 families).

In the enumeration below, the locality is specifically indicated by a symbol in the bracket which refers to the Forest Division (D) and number of the Forest Range as given in the map (Fig. 1). Each locality is however, represented by a field number/numbers in respective order.

All the collections noted in the paper are available in the Central National Herbarium, Botanical Survey of India, Howrah (CAL) except B. Krishna's collections which are deposited in the Herbarium of Industrial Section, Botanical Survey of India (BSIS).

Systematic enumeration
DICOTYLEDONS
Ranunculaceae

Clematis gouriana Roxb. ex DC.
Chunabhati (D5), 900 m, *Sikdar* 993.
Naravelia zeylanica (Linn.) DC.
Poro (D1), *Sikdar* 806; Rajabhatkhawa (D3), *Sikdar* 7077.
Ranunculus diffusus DC.
On way to Sinchu (D5), 1800 m, *Sikdar* 6955.

Magnoliaceae

Talauma hodgsoni Hook. f. & Thoms.
On way to Buxaduar (D5), 550 m, *Sikdar* 4607; Near Buxaduar range office (D5), 625 m, *Sikdar* 943.

Annonaceae

***Desmos dumosus** (Roxb.) Safford
On way to Tobgaon (D5), 1000 m, *Sikdar* 4632.
Miliusa roxburghiana (Wall. ex Griff.) Hook. f. & Thoms.
On way to Buxaduar (D5), 500 m, *Sikdar* 4593.

Menispermaceae

Stephania japonica (Thunb.) Miers
Poro (D1), *Sikdar* 923.
Tinospora cordifolia (Willd.) Hook. f. Thoms.
On way to Sinchu (D5), 1500 m, *Sikdar* 4686.

Papaveraceae

Argemone mexicana Linn.
Rajabhatkhawa (D3), *Sikdar* 7027; Raimatong (D5), *Sikdar* 7028.

Brassicaceae (=Cruciferae)

Brassica juncea (Linn.) Czern. & Coss.
Bhutanghat (D6), *Sikdar* 4098; Balapara (D7), *Sikdar* 4206.
Rorippa indica (Linn.) Hiern.
North Rajabhatkhawa (D3), *Sikdar* 6984.

Capparidaceae

Capparis olacifolia Hook. f. & Thoms.
Way to Tobgaon (D5), 750 m, *Sikdar* 4634.
Cleome viscosa Linn.
Rajabhatkhawa (D3), *Sikdar* 7030.

Violaceae

Viola arcuata Bl.
Ramiti (D5), 1200 m, *Sikdar* 4689.
Viola pilosa Bl.
Chapchikam, on way to Sinchula (D5), 1400 m, *Sikdar* 4673.

Bixaceae

Xylosma longifolium Clos
Poro (D1), *Sikdar* 831.

Caryophyllaceae

Drymaria cordata (Linn.) Willd. ex Roem. & Schult.
Damanpur (D2), *Sikdar* 781; South Rajabhatkhawa (D3), *Sikdar* 904; Buxaduar (D5), 800 m, *Sikdar* 4627; Tashigaon (D5), 600 m, *Sikdar* 4238.
Polycarpon prostratum (Forssk.) Asck. & Schweinf.
South Rajabhatkhawa (D3), *Sikdar* 6976; Rajabhatkhawa (D3), *Sikdar* 7036.

THEACEAE

Camellia kissi Wall.
Buxaduar (D5), 650 m, *Sikdar* 4052.
Schima wallichii (DC.) Korthals
Chunabhati (D5), 1000 m, *Sikdar* 1000; Buxaduar (D5), 800 m, *Sikdar* 4639.

SAURAUIACEAE

Saurauia fasciculata Wall.
Way to Sinchu (D5), 1700 m, *Sikdar* 6953.

DIPTEROCARPACEAE

Shorea robusta Gaertn. f.
Rajabhatkhawa (D3), *Sikdar* 7049.
Vatica lanceaefolia Bl.
Poro (D1), *B. Krishna* 460

MALVACEAE

Abutilon indicum (Linn.) Sweet
Rajabhatkhawa (D3), *Sikdar* 7080.
Hibiscus sabdariffa Linn.
Moynabari, Bhutanghat (D6), *Sikdar* 4142.
Malvastrum coromandelinum (Linn.) Gracke
Rajabhatkhawa (D3), *Sikdar* 7081.
Malvaviscus conzattii Greenman.
Garam (D2), *Sikdar* 883.
Sida acuta Burm. f.
Bhutanghat (D6), 300 m, *Sikdar* 4100.
S. cordifolia Linn.
Near Buxaduar (D5), 750 m, *Sikdar* 6929.

TILIACEAE

Grewia serrulata DC.
Poro (D1), *Sikdar* 901; North Bholka (D7), *Sikdar* 4148.
Triumfetta rhomboidea Jacq.
Poro (D1), *Sikdar* 760; Garam (D2), *Sikdar* 894; North Bholka (D7), *Sikdar* 4175.

ELAEOCARPACEAE

Elaeocarpus sikkimensis Masters
Chapchikam, on way to Sinchu (D5), *Sikdar* 6913.

OXALIDACEAE

Biophytum sensitivum (Linn.) DC.
Tashigaon (D5), 1100 m, *Sikdar* 4041; Way to Buxaduar (D5), 700 m, *Sikdar* 7084.
Oxalis corniculata Linn.
Way to Tobgaon (D5), 900 m, *Sikdar* 4620.

BALSAMINACEAE

Impatiens balsamina Linn.
Rajabhatkhawa (D3), *Sikdar* 7011; Tashigaon (D4), 800 m, *Sikdar* 4005.
I. exilis Hook. f.
Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2613.
I. trilobata Coleb.
Mahakalguri, Alipurduar (D3), *E. A. Heawood* 65.
I. tripetala Roxb.
Buxa road (D3), *K. Biswas* 1627; Buxa to Chunabhati (D5), 850 m, *V. Narayanswami* 2613.

RUTACEAE

Citrus auruntium Linn.
Lapchakhawa (D5), 1100 m, *Sikdar* 950.
Clausena excavata Burm. f.
North Rajabhatkhawa (D3), *Sikdar* 6978.
Glycosmis arborea (Roxb.) Correa
Bhutanghat (D6), *Sikdar* 4140; South Bholka (D7), *Sikdar* 4211; South Rajabhatkhawa (D3), *Sikdar* 4246; Buxaduar (D5), 650 m, *Sikdar* 6925.
Todalia asiatica (Linn.) Lamk.
Buxaduar (D5), 800 m, *Sikdar* 4643; Way to Sinchula (D5), *K. Biswas* 2071.

SIMAROUBACEAE

Picrasma javanica Bl.
North Rajabhatkhawa (D3), *Sikdar* 6985; Buxa to Jainti (D4), *V. Narayanswami* 3016.

BURSERACEAE

Garuga pinnata Roxb.
Way to Buxaduar (D5), 500 m, Sikdar 7085.

MELIACEAE

Amoora wallichii King.
Poro rest house campus (D1), *B. Krishna* 204.

Aphanamixis polystachya (Wall.) Parker
South Rajabhatkhawa (D3), *Sikdar* 4248.

Azadirachta indica A. Juss.
Rajabhatkhawa (D3), *Sikdar* 7039.

Toona ciliata Roem.
Poro (D1), *B. Krishna* 467; 475.

Walsura tubulata Hiern.
Buxaduar (D5), 800 m, *Sikdar* 6936; Chunabhati (D5), 950 m, *Sikdar* 4652.

CELASTRACEAE

Celastrus paniculatus Willd.
Chikoh (D2), *Sikdar* 906.

Eunymus frigidus Heyne ex Wall.
Road to Murichom, 39th Mile (D5), 1600 m, *V. Narayanswami* 2788.

Salacia roxburghii Wall. ex Hook. f.
Tobgaon, on way to Buxaduar (D5), 850 m, *Sikdar* 4616.

RHAMNACEAE

Rhamnus nepalensis Wall. ex Roxb.
South Rajabhatkhawa (D3), *Sikdar* 274; Lapchakhawa (D5), 850 m, *Sikdar* 4061.

Ziziphus mauritiana Lamk.
North Bholka (D7), *Sikdar* 4147.

Z. rugosa Lamk.
Rajabhatkhawa (D3), *Sikdar* 7086.

VITACEAE

Ampelocissus barbatus (Wall.) Planch.
Rajabhatkhawa (D3), *V. Narayanswami* 2445.

Cayratia japonica (Thunb.) Gagnep.
Poro (D1), *Sikdar* 801; Buxa-Bhutan road (D5), 1200 m, *V. Narayanswami* 2586.

Cissus adnata Roxb.
Garam (D2), *Sikdar* 869; South Rajabhatkhawa (D3), *Sikdar* 7091.

Tetrastigma dubium (Laws.) Planch.
Tobgaon (D5), 1400 m, *V. Narayanswami* 2677; 2679.

T. lanceolarium Planch.
South Rajabhatkhawa (D3), *Sikdar* 4265.

T. rumispermum (Laws.) Planch.
Tobgaon (D5), 1400 m, *V. Narayanswami*, 2674.

LEEACEAE

Leea edgewarthii Santapau
Way to Buxaduar (D5), 800 m, *Sikdar* 4640.

L. indica (Burm. f.) Merr.
Rajabhatkhawa (D3), *Sikdar* 7093; Jainti (D4), *V. Narayanswami* 3000.

L. macrophylla Roxb. ex Hornem.
North Rajabhatkhawa (D3), *Sikdar* 6992.

SAPINDACEAE

Aphania rubra (Roxb.) Radlk.
South Bholka (D7), *Sikdar* 4213.

Dimocarpus longan Lour.
Rajabhatkhawa (D3), *Sikdar* 7095.

Sapindus laurifolia Vahl.
Rajabhatkhawa (D3), *Sikdar* 7094.

HIPPOCASTANACEAE

Aesculus assamica Griffith
Rajabhatkhawa (D3), *C. R. Das* 68; Poro (D1), *B. Krishna* 459.

SABIACEAE

*Sabia paniculata** Edgew. ex Hook. f. & Thoms.
North Bholka (D7), *Sikdar* 4178.

ANACARDIACEAE

Anacardium occidentale Linn.
Poro (D1), *B. Krishna* 447.
Mangifera indica Linn.
Buxaduar (D5), 600 m, *Sikdar* 7096.
Semecarpus anacardium Linn. f.
Rajabhatkhawa (D3), *Sikdar* 7191.

MORINGACEAE

Moringa oleifera Lamk.
Poro (D1), *B. Krishna* 455.

FABACEAE (=PAPILIONACEAE)

Clitoria ternatea Linn.
Chengmari (D7), *Sikdar* 7041.
*Crotalaria humifusa** Grah.
Mahakalguri, Alipurduar (D3), *E. A. Heawood* 113.
C. pallida Ait.
Moynabari (D6), *Sikdar* 4146; North Bholka (D7), *Sikdar* 4150; Buxaduar (D5), 8000 m, *Sikdar* 4625.
*Dalbergia duarensis** Thoth.
Mahakalguri, Alipurduar (D3), *E. A. Heawood* 104.
D. stipulacea Roxb.
Damanpur (D2), *Sikdar* 920; Bhutanghat (D6), 310 m, *Sikdar* 4085.
Desmodium caudatum (Thunb.) DC.
Poro (D1), *Sikdar* 824; Garam (D2), *Sikdar* 881; South Bholka (D7), *Sikdar* 4219.
D. gangeticum (Linn.) DC.
Poro (D1), *Sikdar* 809.
D. heterocarpon (Linn.) DC.
Poro (D1), *Sikdar* 784; 800.
D. tiliaefolium (D. Don) Wall. ex G. Don
Poro (D1), *Sikdar* 839.
D. triangulare (Retz.) Merr.
Bhutanghat (D6), Sikdar 4075.
Dolichos biflorus Linn.
Balapara (D7), *Sikdar* 4239.
Dysolobium tetragonum Prain
Alipurduar (D3), *E. A. Heawood* 36.
Indigofera stachyoides Lindl.
Way to Sinchu (D5), 1600 m, *Sikdar* 6911; Ramiti, on way to Sinchu (D5), 1400 m, *Sikdar* 4021.
Panchyrhizus angulatus Rich.
Poro (D1), *Sikdar* 608.
Pueraria subspicata Benth.
Garam (D2), *Sikdar* 873.
Uraria rufescens (DC.) Schindl.
Poro (D1), *Sikdar* 816.

CAESALPINIACEAE

Bauhinia acuminata Linn.
Poro (D1), *Sikdar* 805.
Caesalpinia cucullata Roxb.
Poro (D1), *Sikdar* 844; Bhutanghat (D6), *Sikdar* 4121.
Cassia siamea Lamk.
Poro (D1), *Sikdar* 918.
C. tora Linn.
South Bholka (D7), *Sikdar* 4227.
Phanera purpurea (Linn.) Benth.
Rajabhatkhawa (D3), *Sikdar* 4243.
Piliostigma malabaricum (Roxb.) Benth.
Central Raidak (D6), *Sikdar* 4134.

MIMOSACEAE

Acacia chundra (Roxb. ex Rottler) Willd.
Bhutanghat (D6), *Sikdar* 4097.
A. pennata (Linn.) Willd.
Way to Santrabari (D5), 300 m, *Sikdar* 6922; Buxa to Tobgaon (D5), 750 m, *V. Narayanswami* 2662; Tobgaon (D5), 800 m, *K. Biswas* 3221.

A. sinuata (Lour.) Merr.
Road to Murichom, Buxaduar (D5), 1700 m, *V. Narayanswami* 2801.

A. torta (Roxb.) Craib.
South Rajabhatkhawa (D3), *Sikdar* 4247.

Mimosa intsia Linn.
Buxa (D), *V. Narayanswami* 2626.

M. pudica Linn.
Poro (D1), *Sikdar* 761; Garam (D2), *Sikdar* 895.

Samanea saman (Jacq.) Merr.
North Rajabhatkhawa (D3), *Sikdar* 6986.

ROSACEAE

Duchesnea indica (Andr.) Focke
South Bholka (D7), *Sikdar* 4197; Poro (D1), *B. Krishna* 468.

Potentilla sundaica (Bl.) O. Kuntze
Ramiti, Buxaduar (D5), 1100 m, *Sikdar* 6916.

Prunus persica (Linn.) Stokes
Buxaduar (D5), 800 m, *Sikdar* 4590.

Pyrus communis Linn.
Buxaduar (D5), 800 m, *Sikdar* 6963.

Rubus ellipticus Smith
Way to Sinchu (D5), 1700 m, *Sikdar* 6958.

PHILADELPHACEAE

Dichroa febrifuga Lour.
Sinchu (D5), 1800 m, *Sikdar* 4690; Way to Sinchu (D5), 1700 m, *Sikdar* 6943.

ESCALLONIACEAE

Itea macrophylla Wall.
On way to Sinchu (D5), 1350 m, *Sikdar* 4677.

CRASSULACEAE

Kalanchoe integra (Medik.) O. Kuntze
Lapchakhawa (D5), 1000 m, *Sikdar* 967; Chunabhati (D5), 800 m, *Sikdar* 4002.

Sedum multicaule Wall.
Chunabhati (D5), 1000 m, *Sikdar* 4664.

COMBRETACEAE

Combretum flagocarpum C. B. Clarke
Buxaduar (D5), 900 m, *Sikdar* 962; Way to Tobgaon (D5), 1100 m, *Sikdar* 4622.

MYRTACEAE

Eugenia formosa Wall.
Rajabhatkhawa (D3), *V. Narayanswami* 2472.

Syzygium cumini (Linn.) Skeels
Poro (D1), *B. Krishna* 479.

S. oblatum (Roxb.) Wall. ex Cowan & Cowan.
Tashigaon (D5), 1100 m, *Sikdar* 4020.

S. samarangense (Bl.) Merr.
Rajabhatkhawa ((D3), *Sikdar* 7106.

MELASTOMATACEAE

Medinilla rubicunda (Jack) Bl.
On way to Sinchu (D5), 1400 m, *Sikdar* 4696.

Melastoma malabathricum Linn.
Garam (D2), *Sikdar* 851; Poro (D1), *Sikdar* 766; Buxaduar (D5), 900 m, *Sikdar* 7107.

M. normale D. Don
Way to Tobgaon (D5), 1200 m, *Sikdar* 4637; way to Sinchu (D5), 1700 m, *Sikdar* 4699.

Osbeckia crinita Benth. ex C. B. Clarke
Way to Sinchu (D5), 1200 m, *Sikdar* 6942.

O. nepalensis Hook.
Poro (D1), *B. Krishna* 453.

O. nutans Wall. ex C. B. Clarke
Buxaduar (D5), 900 m, *Sikdar* 4051.

Oxyspora paniculata (D. Don) DC.
Way to Sinchu (D5), 1700 m, *Sikdar* 4687.

Lythraceae

Ammannia baccifera Linn.
South Bholka (D7), *Sikdar* 4203.

Lagerstroemia speciosa (Linn.) Pers.
North Rajabhatkhawa (D3), *Sikdar* 6983; Poro (D1), *B. Krishna* 491.

Rotala indica (Willd.) Koehne
South Bholka (D7), *Sikdar* 4209.

Onagraceae

Ludwigia octovalvis ssp. **sessiliflora** (Micheli) Raven
North Bholka (D7), *Sikdar* 4154; South Bholka (D7), *Sikdar* 4226.

L. perennis Linn.
Poro (D1), *Sikdar* 830; Rajabhatkhawa (D3), *Sikdar* 4244.

Cucurbitaceae

Coccinia grandis (Linn.) Voigt
Rajabhatkhawa (D3), *Sikdar* 7112.

Cucumis melo Linn.
Balapara (D7), *Sikdar* 4240.

Diplocyclos palmatus (Linn.) Jeffrey
Tashigaon (D5), 1200 m, *Sikdar* 4031.

Hodgsonia macrocarpa (Bl.) Cogn.
21 mile from Rajabhatkhawa (D3), *V. Narayanswami* 2325.

Melothria leucocarpa (Bl.) Cogn.
Tashigaon (D5), 1000 m, *Sikdar* 4023.

Momordica dioica Roxb. ex Willd.
Rajabhatkhawa (D3), *Sikdar* 7125.

Mukia maderaspatana (Linn.) M. Roem.
Damanpur (D2), *Sikdar* 911; North Bholka (D7), *Sikdar* 4164.

Sechium edule (Jacq.) Sw.
Buxaduar (D5), 1000 m, *Sikdar* 957.

Solena heterophylla Lour.
Poro (D1), *Sikdar* 772.

Trichosanthes bracteata (Lamk.) Voigt
Buxa-Bhutan road (D5), 1700 m, *V. Narayanswami* 2770.

T. truncata C. B. Clarke
Rajabhatkhawa (D3), *V. Narayanswami* 2420.

T. wallichiana (Ser.) Wight
Buxa-Bhutan road (D5), 1400 m, *V. Narayanswami* 2961.

Begoniaceae

Begonia nepalensis (A.DC.) Warburg
On way to Buxaduar (D5), 800 m, *Sikdar* 934; way to Buxaduar (D5), 1000 m, *K. Biswas* 1930.

B. palmata D. Don
On way to Sinchu (D5), 1800 m, *Sikdar* 4678; Buxa-Bhutan road (D5), 1300 m, *V. Narayanswami* 2600; way to Sinchu (D5), 1400 m, *K. Biswas* 1985.

B. rubro-venia Hook. f.
Buxaduar (D5), 900 m, *Sikdar* 4050; Buxa-Bhutan road (D5), 1200 m, *Sikdar* 2576; Tobgaon (D5), 1150 m, *V. Narayanswami* 2692.

B. xanthina Hook.
On way to Sinchu (D5), 1200 m, *Sikdar* 4018.

Cactaceae

Opuntia elatior Mill.
Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2654.

Molluginaceae

Glinus lotoides Linn.
Rajabhatkhawa (D3), *Sikdar* 7113.

Apiaceae (=Umbelliferae)

Centella asiatica (Linn.) Urban.
Lapchakhawa (D5), 1100 m, *Sikdar* 945; Poro (D1), *B. Krishna* 484.

***Eryngium foetidum** Linn.
North Rajabhatkhawa (D3), *Sikdar* 6979; Rajabhatkhawa (D3), *V. Narayanswami* 2364.

Hydrocotyle javanica Thunb.
Buxaduar (D5), 1000 m, *Sikdar* 4671; On way to Sinchu (D5), 1200 m, *Sikdar* 6964; Rajabhatkhawa (D3), *K. Biswas* 3069.

Oenanthe javanica (Bl.) DC.
North Rajabhatkhawa (D3), *Sikdar* 7005; Rajabhatkhawa (D3), *V. Narayanswami* 2464; Poro (D1), *B. Krishna* 466

CAPRIFOLIACEAE

Viburnum colebrookianum Wall. ex C. B. Clarke
Garam (D2), *Sikdar* 865; North Rajabhatkhawa (D3), *Sikdar* 6998; Buxa road (D3), *K. Biswas* 1711; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2353.

SAMBUCACEAE

Sambucus canadensis Linn.
Buxaduar (D5), 1100 m, *Sikdar* 4029.

RUBIACEAE

Borreria articularis (Linn. f.) F. N. Williams
Garam (D2), *Sikdar* 866; Poro (D1), *Sikdar* 792; South Rajabhatkhawa (D3), *Sikdar* 4273; Balapara (D7), *Sikdar* 4184; Buxaduar (D5), 1000 m, *Sikdar* 947; Tashigaon (D5), 1100 m, *Sikdar* 4057.

Hedyotis pinifolia var. **caespitosa** Wall. ex G. Don
Rajabhatkhawa (D3), *C. R. Das* 31.

Ixora nigricans R. Br. ex Wt. & Arn.
Poro, 16 km from Rajabhatkhawa (D1), *B. Krishna* 457.

Leptodermis lanceolata Wall.
On way to Sinchu (D5), 1600 m, *K. Biswas* 2017.

Meyna laxiflora Robyns
Buxa, north-west & north-east (D5), 800 m, *V. Narayanswami* 2722.

Morinda angustifolia Roxb.
Poro (D1), *Sikdar* 763; Garam (D2), *Sikdar* 864; South Rajabhatkhawa (D3), *Sikdar* 4262; Rajabhatkhawa (D3), *V. Narayanswami* 2382; Buxa to Santrabari (D5), 650 m, *V. Narayanswami* 2860.

Neanotis wightiana (Wall. ex Wt. et Arn). W. H. Lewis
Poro (D1), *Sikdar* 802; Garam (D2), Sikdar 867; Bhutanghat (D6), *Sikdar* 4118.

+**Ophiorrhiza seshagiriana** Sikdar et Maiti
Way to Sinchu (D5), 1800 m, *Sikdar* 4681.

Uncaria sessilifructus Roxb.
South Bholka (D7), *Sikdar* 4208.

Vangueria spinosa Roxb.
Buxa (D5), 800 m, *V. Narayanswami* 2722.

Wendlandia pendula DC.
Chunabhati (D5), 1200 m, *Sikdar* 986; 987.

Xeromphis spinosa (Thunb.) Keay
Garam (D2), *Sikdar* 885; South Bholka (D7), *Sikdar* 4194; Jainti (D4), *V. Narayanswami* 3009; Buxa road (D3), *K. Biswas* 1682; Poro (D1), *B. Krishna* 493.

ASTERACEAE (=COMPOSITAE)

Adenostemma lavenia (Linn.) O. Kuntze
Poro (D1), *Sikdar* 822; Damanpur (D2), *Sikdar* 915; Balapara (D7), *Sikdar* 4192; Tashigaon (D5), 1200 m, *Sikdar* 4014.

Ageratum conyzoides Linn.
South Bholka (D7), *Sikdar* 4193; Tashigaon (D5), 1000 m, *Sikdar* 4055; Poro (D1), *B. Krishna* 214.

Artemisia nilagirica (C. B. Clarke) Pamp.
South Bholka (D7), *Sikdar* 4225; Buxaduar (D5), 900 m, *Sikdar* 952; Tashigaon (D5), 1100 m, *Sikdar* 4064.

Bidens biternata (Lour.) Merr. et Sherff ex Sherff
Bhutanghat (D6), *Sikdar* 4106; Buxaduar (D5), 1200 m, *Sikdar* 951.

Blumea lanceolaria (Roxb.) Druce
On way to Buxaduar (D5), 700 m, *K. Biswas* 1793.

Crassocephalum crepidioides (Benth.) S. Moore
Damanpur (D2), *C. R. Das* 41.

Eclipta prostrata (Linn.) Linn.
Balapara (D7), *Sikdar* 4228; North Rajabhatkhawa (D3), *Sikdar* 6993.

Elephantopus scaber Linn.
Poro (D1) *Sikdar* 817.

Emilia sonchifolia (Linn.) DC.
Garam (D2), *Sikdar* 856.

Erechtites valerianifolia (Wolf) DC.
North Bholka (D7), *Sikdar* 4167; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2309; Poro (D1), *B. Krishna* 233.

Eupatorium odoratum Linn.
Garam (D2), *Sikdar* 869; Poro (D1), *Sikdar* 787; Bhutanghat (D6), *Sikdar* 4112; South Rajabhatkhawa (D3), *Sikdar* 4256; Tashigaon (D5), 1250 m, *Sikdar* 4054; Near poro rest house (D1), *B. Krishna* 238.

Lactuca dolichophylla Kitamura
On way to Buxaduar (D5), 850 m, *Sikdar* 7825.

Laggera aurita Sch.-Bip.
Near poro rest house (D1), *B. Krishna* 495.

Mikania cordata (Burm. f.) Robinson var. **indica** Kitamura
Garam (D2), *Sikdar* 861; Poro (D1), *Sikdar* 812; Central Raidak (D6), *Sikdar* 4236, South Bholka (D7), *Sikdar* 4186; Lapchakhawa (D5), 1100 m, *Sikdar* 4046.

*****Senecio bhot** C. B. Clarke
Buxaduar (D5), 950 m, *Sikdar* 973; Ramiti (D5), 1400 m, *Sikdar* 4017; Tashigaon (D5), 1200 m, *Sikdar* 4068.

Sigesbeckia orientalis Linn.
Lapchakhawa (D5), 1200 m, *Sikdar* 958; Buxaduar (D5), 1100 m, *Sikdar* 4035; Tashigaon (D5), 1000 m, *Sikdar* 4060.

Sphaeranthus indicus Linn.
Bholka (D7), *Sikdar* 4237.

Spilanthes paniculata Wall.
South Rajabhatkhawa (D3), *Sikdar* 4275; Lapchakhawa (D5), 1200 m, *Sikdar* 954; Tashigaon (D4), 1100 m, *Sikdar* 4039.

Synedrella nodiflora (Linn.)) Gaertn.
South Rajabhatkhawa (D3), *Sikdar* 755; Bhutanghat (D6), *Sikdar* 4258; Tashigaon (D5), 1100 m, *Sikdar* 4079; Buxaduar (D5), 1000 m, *Sikdar* 4629.

Tagetes erecta Linn.
Tashigaon (D5), 1200 m, *Sikdar* 4012; Tashigaon (D5), 1000 m, *Sikdar* 4070.

***Thespis divaricata** DC.
Rajabhatkhawa (D3), *Sikdar* 6977.

Tithonia diversifolia (Henusl.) A. Gray
Bhutanghat (D6), *Sikdar* 4105; Buxaduar (D5), 1100 m, *Sikdar* 978.

Tridax procumbens Linn.
Garam (D2), *Sikdar* 882.

Vernonia cinerea (Linn.) Less.
Garam (D2), *Sikdar* 853; 860.

V. saligna DC.
Tashigaon (D4), 1000 m, *Sikdar* 4049; Bhutanghat (D6), 300 m, *Sikdar* 4113.

V. volkameriaefolia DC.
Way to Sinchu (D5), 1700 m, *Sikdar* 6949.

Wedelia wallichii Less.
Bhutanghat (D6), *Sikdar* 4110; Balapara (D7), *Sikdar* 4189; North Rajabhatkhawa (D3), *Sikdar* 6982.

Xanthium strumarium Linn.
Bhutanghat (D6), *Sikdar* 4094; Poro (D1), *B. Krishna* 495.

Youngia japonica (Linn.) DC.
Buxaduar (D5), 700 m, *Sikdar* 6923.

Lobeliaceae

Lobelia angulata Forst.
Lapchakhawa (D5), 1250 m, *Sikdar* 945; Buxa-Bhutan road (D5), 900 m, *V. Narayanswami* 2502.
L. zeylanica Linn.
Rajabhatkhawa (D3), *Sikdar* 4263.

Vacciniaceae

Agapetes saligna (Hook. f.) Hook. f.
Way to Sinchu (D5), 1800 m, *Sikdar* 4691; Tobgaon (D5), 1250 m, *V. Narayanswami* 2698.

Plumbaginaceae

Plumbago zeylanica Linn.
Poro (D1), *Sikdar* 813; Lapchakhawa (D5), 850 m, *Sikdar* 4661.

Primulaceae

Lysimachia decurrens Forst. f.
Buxa-Bhutan road (D5), 1250 m, *K. Biswas* 2592; Buxa northwest (D5), 900 m, *V. Narayanswami* 2734.

Myrsinaceae

******Amblyanthopsis bhotanica*** (C. B. Clarke) Mez
On way to Sinchu (D5), 1700 m, *Sikdar* 4683.
Ardisia crispa (Thunb.) A. DC.
Way to Sinchu (D5), 1700 m, *Sikdar* 4684.
Maesa chisia Buch.-Ham. ex D. Don
Way to Sinchu (D5), 1400 m, *Sikdar* 6941; Sinchu (D5), 1700 m, *Sikdar* 6952; Way to Bhutan from Buxaduar (D5), 1500 m, *Sikdar* 6945.
M. indica (Roxb.) A. DC.
Garam (D2), *Sikdar* 892; South Bholka (D7), *Sikdar* 4221; Rajabhatkhawa (D3), *K. Biswas* 1555; Poro (D1), *B. Krishna* 482.

Symplocaceae

Symplocos laurina (Retz.) Wall. ex G. Don
Poro (D1), *B. Krishna* 472.

Oleaceae

Jasminum amplexicaule Buch.-Ham. ex G. Don
South Rajabhatkhawa (D3), *Sikdar* 4251; Buxaduar (D5), 1000 m, *Sikdar* 955.
J. dispermum Wall.
Way to Sinchu (D5), 1750 m, *Sikdar* 4682.
J. scandens Vahl.
Poro (D1), *B. Krishna* 478.
Ligustrum robustum Bl.
Way to Sinchu (D5), 1750 m, *Sikdar* 6940.

Apocyanaceae

*__Aganosma gracilis__ Hook. f.
Chunabhati (D5), 1600m, *Sikdar* 4660.
Allamanda cathartica Linn.
Poro (D1), *Sikdar* 765; Chunabhati (D5), 1100 m, *Sikdar* 4663; Poro (D1), *B. Krishna* 449.
Alstonia scholaris (Linn.) R. Br.
Poro (D1), *B. Krishna* 498.
*__Anodendron paniculatum__ A. DC.
Around Poro forest (D1), *B. Krishna* 464.
Catharanthus roseus (Linn.) G. Don.
Balapara (D7), *Sikdar* 4190.
Chonemorpha fragrans (Moon) Alston
Buxaduar (D5), 1100m, *Sikdar* 7042.
Holarrhena antidysenterica (Roth) A. DC.
Way to Buxaduar (D5), 600m, *Sikdar* 4598.
Ichnocarpus frutescens (Linn.) R. Br.
South Bholka (D7), *Sikdar* 4216.
Nerium indicum Mill.
Rajabhatkhawa (D3), *Sikdar* 7058.
Plumeria rubra Linn.
Buxaduar (D5), 100 m, *Sikdar* 6920.
Rauvolfia serpentina (Linn.) Benth. ex Kurz
Bhutanghat (D6), *Sikdar* 4086.

Tabernaemontana divaricata (Linn.) R. Br. ex Roem. et Schult.
Santrabari (D5), *Sikdar* 924; Bhutanghat (D6), 350 m, *Sikdar* 4119; South Rajabhatkhawa (D3), *Sikdar* 4252.

Trachelospermum lucidum (D. Don) K. Schummann
Way to Sinchu (D5), 1700 m, *Sikdar* 6960.

Wrightia coccinea Sims
Way to Buxaduar (D5), 800 m, *Sikdar* 7167; Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2612.

W. tomentosa (Roxb.) Roem. et Schult.
North Rajabhatkhawa (D3), *Sikdar* 6989.

ASCLEPIADACEAE

*__Ceropegia anguistifolia__ Wight
Mahakalguri, Alipurduar (D1), *E. A. Heawood* 73.

Dischidia benghalensis Coleb.
Buxaduar (D5), 800 m, *Sikdar* 4668.

Hoya arnottiana Wight
Buxaduar (D5), 1200 m, *K. Biswas* 1738.

H. lanceolata Wall. ex D. Don
On way to Ramiti, Buxaduar (D5), 1200 m, *Sikdar* 7166; on way to Sinchula (D5), 1700 m, *K. Biswas* 2024.

*__H. obcordata__ Hook. f.
On way to Sinchula (D5), 1700 m, *K. Biswas* 2001.

Marsdenia tinctoria R. Br.
Poro (D1), *Sikdar* 807; South Rajabhatkhawa (D3), *Sikdar* 4267; Buxa road (D3), *K. Biswas* 1684.

PERIPLOCACEAE

Cryptolepis buchananii Roem. et Schult.
Rajabhatkhawa (D3), *K. Biswas* 1717.

C. sinensis (Lour.) Merr.
Rajabhatkhawa (D3), *K. Biswas* 1561; 1574; Buxa road (D3), *K. Biswas* 1654; Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2656; Alipurduar (D3), *C. R. Das* 73.

MENYANTHACEAE

Nymphoides cristata (Roxb.) O. Kuntze
Bhutanghat (D6), *Sikdar* 4074.

HYDROPHYLLACEAE

Hydrolea zeylanica (Linn.) Vahl
Poro (D1), *Sikdar* 770; Garam (D2), *Sikdar* 854.

BORAGINACEAE

Cordia dichotoma Forst. f.
Poro (D1), *B. Krishna* 470.

Heliotropium indicum Linn.
Poro (D1), *B. Krishna* 497.

H. strigosum Willd.
Garam (D2), *Sikdar* 849.

CONVOLVULACEAE

Argyreia hookeri Clarke
Poro (D1), *Sikdar* 838; Bhutanghat (D6), *Sikdar* 4111.

Erycibe laevigata Wall. ex C. B. Clarke
Way to Sinchu (D5), 1800 m, *Sikdar* 6937.

Evolvulus nummularius (Linn.) Linn.
Way to Buxa (D3), *C. R. Das* 80.

Ipomoea batatus (Linn.) Lamk.
Balapara (D7), *Sikdar* 4195.

Merremia hederacea (Burm. f.) Hall. f.
Balapara (D7), *Sikdar* 4230.

M. umbellata (Linn.) Hall. f.
Rajabhatkhawa (D3), *C. R. Das* 94.

Porana paniculata Roxb.
Buxaduar (D5), 1150 m, *Sikdar* 4040.

P. racemosa Roxb.
Ramiti, Buxaduar (D5), 1250 m, *Sikdar* 4019.

Cuscutaceae

Cuscuta reflexa Roxb.
Poro (D1), *Sikdar* 837; Balapara (D7), *Sikdar* 4241; Poro (D1), *B. Krishna* 471.

Solanaceae

Brugmasia suaveolens (Humb. & Bonpl. ex. Willd.) Bercht. & Presl
Buxaduar (D5), 800 m, *K. Biswas* 1922.

Capsicum frutescens Linn.
Bhutanghat (D6), 350 m, *Sikdar* 4102.

Cestrum nocturnum Linn.
Chunabhati (D5), 1100 m, *Sikdar* 997.

Datura metel Linn.
Way to Santrabari (D5), *Sikdar* 6928.

Nicotiana plumbaginifolia Viviani
Rajabhatkhawa (D3), *Sikdar* 7059.

Physalis minima Linn.
Bhutanghat (D6), *Sikdar* 4099; South Bholka (D7), *Sikdar* 4174.

Solanum erianthum D. Don
Buxaduar (D5), 800 m, *Sikdar* 4133.

S. khasianum C. B. Clarke
South Bholka (D7), *Sikdar* 4182; North Rajabhatkhawa (D3), *Sikdar* 6991; on way to Tobgaon (D5), 1200 m, *K. Biswas* 2046; Alipurduar (D3), *C. R. Das* 75.

S. nigrum Linn.
South Bholka (D7), *Sikdar* 4183.

S. torvum Sw.
Garam (D2), *Sikdar* 847; South Bholka (D7), *Sikdar* 4149; Balapara (D7), *Sikdar* 4215.

Scrophulariaceae

Limnophila chinensis (Osbeck.) Merr.
Damanpur (D2), *Sikdar* 907.

L. sessiliflora (Vahl.) Bl.
Cheko (D2), *Sikdar* 917; Poro (D1), *Sikdar* 752 North Bholka (D7), *Sikdar* 4155; South Bholka (D7), *Sikdar* 4229; Rajabhatkhawa (D3). *K. Biswas* 1640.

*__Lindenbergia hookeri__ C. B. Clarke ex Hook. f. et Thoms.
Way to Buxaduar (D5), 650 m, *K. Biswas* 1755.

L. indica (Linn.) Vatke
Buxaduar forest (D5), 750 m, *Sikdar* 969.

L. muraria (Roxb.) Bruhl
On way to Buxaduar forest (D5), 800 m, *Sikdar* 946.

Lindernia ciliata (Colsm.) Pennell
South Rajabhatkhawa (D3), *Sikdar* 4279; North Rajabhatkhawa (D3), *Sikdar* 6995.

L. cordifolia (Colsm.) Merr.
Poro (D1), *Sikdar* 777; South Bholka (D7), *Sikdar* 4210; 4236.

L. procumbens (Krock.) Philcox
South Bholka (D7), *Sikdar* 4235.

L. pusilla (Willd.) Boldingh
South Rajabhatkhawa (D3), *Sikdar* 428.

L. ruellioides (Colsm.) Pennell
Poro (D1), *Sikdar* 778.

Mazus pumilus (Burm. f.) Steenis
North Rajabhatkhawa (D3), *Sikdar* 6981; Buxaduar (D5), 800 m, *Sikdar* 4630.

M. surculosus D. Don
Way to Ramiti, Buxaduar (D5), 1200 m, *Sikdar* 6951.

Scoparia dulcis Linn.
Poro (D1), *Sikdar* 793; South Bholka (D7), *Sikdar* 4185; Buxaduar (D5), 800 m, *Sikdar* 4037.

Torenia diffusa D. Don
Poro (D1), *Sikdar* 788.

Gesneriaceae

Aeschynanthus hookeri C. B. Clarke
Tobgaon (D5), 1200 m, *K. Biswas* 205.

A. parviflora (D. Don) Spreng.
Lapchakhawa (D5), 1250 m, *Sikdar* 948; Ramiti (D5), 1400 m, *Sikdar* 4700.

Lysionotus serrata D. Don
Lapchakhawa (D5), 1150 m, *Sikdar* 979; Tobgaon (D5), 1250 m, *K. Biswas* 2063.

BIGNONIACEAE

Jacarandra acutifolia Humb. & Bonpl.
Buxaduar (D5), 800 m, *Sikdar* 4666.

ACANTHACEAE

***Acanthus carduaceous** Griff.
Ramiti, Buxaduar (D5), 1400 m, *Sikdar* 4034; Way to Sinchula (D5), 1450 m, *K. Biswas* 2032.

Adhatoda zeylanica Medic.
Buxaduar (D5), 800 m, *Sikdar* 949.

Barleria strigosa Willd.
Bhutanghat (D6), 300 m, *Sikdar* 4096.

***Dianthera virgata** (Wall. ex Nees) C. B. Clarke
Lapchakhawa (D5), 1200 m, *Sikdar* 972.

Dicliptera roxburghiana Nees
South Rajabhatkhawa (D3), *Sikdar* 4250; Bhutanghat (D6), *Sikdar* 4080; North Bholka (D7), *Sikdar* 4165; Buxaduar (D5), 700 m, *Sikdar* 935; Ramiti (D5), 1600 m, *Sikdar* 4010; Tashigaon (D4); 1000 m, *Sikdar* 4065.

Eranthemum nervosum (Vahl) R. Br. ex Roem. & Schult.
Bhutanghat (D6), 325 m, *Sikdar* 4116.

E. splendens (T. Anders.) Bremek. & Nanneng-Bremk.
Buxaduar (D5), 1200 m, *Sikdar* 990; Way to Buxaduar (D5), 1000 m, *K. Biswas* 1914.

Hygrophila polysperma (Roxb.) T. Anders.
Poro (D1), *Sikdar* 769; Bhutanghat 300 m, *Sikdar* 4083; Balapara (D7), *Sikdar* 4173.

H. salicifolia (Vahl) Nees
Poro (D1), *Sikdar* 758.

Lepidagathis incurva Buch.-Ham. ex D. Don
Poro (D1), *Sikdar* 767; Garam (D2), *Sikdar* 871: Bhutanghat (D6), *Sikdar* 4082; Bholka (D7), *Sikdar* 4199; Tashigaon (D4), 1100 m, *Sikdar* 4048.

Mackaya macrocarpa (Nees) Das
South Bholka (D7), *Sikdar* 4191.

Nelsonia canescens (Lamk.) Spreng.
Buxa-road (D3), *K. Biswas* 1600.

Phaulopsis dorsiflora (Retz.) Santapau
Rajabhatkhawa (D3), *Sikdar* 4268.

Phlogacanthus thyrsiflorus (Roxb.) Nees
Poro (D1), *Sikdar* 776; South Rajabhatkhawa (D3), *Sikdar* 4276.

Rungia pectinata (Linn.) Nees
Poro (D1), *Sikdar* 818; Balapara (D7), *Sikdar* 4157; Bhutanghat (D6), 400 m, *Sikdar* 4077; Buxaduar (D5), 900 m, *Sikdar* 929; Tashigaon (D4), 1100 m, *Sikdar* 4043.

***Strobilanthes anisophyllus** T. Anders.
Way to Buxaduar (D5), 900 m, *Sikdar* 932; Buxaduar (D5), 1000 m, *Sikdar* 966.

S. boerhavioides T. Andr.
Buxaduar (D5), 800 m, *Sikdar*, 936.

S. coloratus (Nees) T. Andr.
Lapchakhawa (D5), 1200 m, *Sikdar* 980; Ramiti (D5), 1400 m, *Sikdar* 4013.

THUNBERGIACEAE

Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.
South Rajabhatkhawa (D3), *Sikdar* 4278; Buxaduar (D5), 800 m, *Sikdar* 4653.

VERBENACEAE

Callicarpa macrophylla Vahl
Balapara (D7), *Sikdar* 4214.

Clerodendrum indicum (Linn.) O. Ktze.
South Rajabhatkhawa (D3), *Sikdar* 4260.

***C. philippinum** Schauer
Chunabhati (D5), 1200 m, *Sikdar* 995; Buxaduar (D5), 1000 m, *Sikdar* 4026; Chunabhati (D5), 1100 m, *Sikdar* 4591.

C. serratum (Linn.) Moon
Poro (D1), *B. Krishna* 451.

C. viscosum Vent.
Way to Buxaduar (D5), 650 m, *Sikdar* 4614.

C. wallichii Merr.
Buxaduar (D5), 1100 m, *Sikdar* 981; Buxa-to Chunabhati (D5), 1200 m, *Sikdar* 989.

Gmelina arborea Roxb.
Poro (D1), *B. Krishna* 450.

Holmskioldia sanguinea Retz.
Santrabari (D5), 500 m, *Sikdar* 933; Bhutanghat (D6), 300 m, *Sikdar* 4114; Tashigaon (D5), 850 m, *Sikdar* 4067.

Lantana camara Linn.
Way to Buxaduar (D5), 900 m, *Sikdar* 925; Buxaduar (D5), 1000 m, *Sikdar* 4611.

Premna coriacea C. B. Clarke
Way to Buxaduar (D5), 600 m, *Sikdar* 6934.

Vitex heterophylla Roxb.
Rajabhatkhawa (D3), *Sikdar* 7060.

LAMIACEAE (=LABIATAE)

Achyrospermum wallichianum (Benth.) Benth. ex Hook. f.
South Rajabhatkhawa (D3), *Sikdar* 4246; Buxaduar (D5), 825 m, *Sikdar* 940; Buxa road (D3), *K. Biswas* 1635.

Ajuga macrosperma Wall. ex Benth.
Buxaduar (D5), 1000 m, *Sikdar* 984; Tashigaon (D5), 1100 m, *Sikdar* 4006; Ramiti (D5), 1500 m, *Sikdar* 4030.

A. macrosperma Wall. ex Benth. var. **breviflora** Hook. f.
Way to Sinchula (D5), 1500 m, *K. Biswas* 2002.

Anisochilus pallidus Wall.
Buxaduar (D5), 1200 m, *Sikdar* 974; Tashigaon (D5), 1250 m, *Sikdar* 4015.

Anisomeles indica (Linn.) O. Ktze.
Poro (D1), *Sikdar* 819; Garam (D2), *Sikdar* 845; Bhutanghat (D6), *Sikdar* 4081; Balapara (D7), *Sikdar* 4169; Buxaduar (D5), 1000 m, *Sikdar* 992.

Colebrookea oppositifolia J. E. Smith
Buxaduar (D5), 1100 m, *Sikdar* 988.

Elsholtzia blanda Benth.
Lapchakhawa (D5), 1100 m, *Sikdar* 971; Chunabhati (D5), 1200 m, *Sikdar* 999; Tashigaon (D4), 1250 m, *Sikdar* 4069.

E. fruticosa (D. Don) Rehder
Tashigaon (D5), 1250 m, *Sikdar* 6902.

Gomphostemma parviflorum Wall. ex Benth.
Buxa road (D3), *K. Biswas* 1612.

Hyptis suaveolens (Linn.) Poit.
Poro (D1), *Sikdar* 791; South Bholka (D7), *Sikdar* 4168; Lapchakhawa (D5), 1050 m, *Sikdar* 4045.

Leucas aspera (Willd.) Link
Rajabhatkhawa (D3), *C. R. Das* 34.

L. lavandulaefolia J. E. Smith
Garam (D2), *Sikdar* 857; Moynabari (D6), *Sikdar* 4144.

L. mollissima Wall. ex Benth.
Poro (D1), *Sikdar* 771.

Plectranthus japonicus (Burm. f.) Koidz
Ramiti (D5), 1600 m, *Sikdar* 4011.

P. striatus Benth.
Ramiti (D5), 1600 m, *Sikdar* 4008.

***Pogostemon auricularius** (Linn.) Hassk.
Poro (D1), *Sikdar* 757; Alipurduar (D3), *E. A. Heawood* 52.

P. benghalense (Burm. f.) O. Ktze.
Buxaduar (D5), 700 m, *Sikdar* 939.

***P. elsholtzioides** Benth.
Buxaduar (D5), 950 m, *Sikdar* 926; Buxaduar (D5), *Sikdar* 970.

P. tuberculosus Benth.
Lapchakhawa (D5), 1200 m, *Sikdar* 4062; way to Buxaduar (D5), 1000 m, *K. Biswas* 1756.

Teucrium viscidum Bl.
Rajabhatkhawa (D3), *Sikdar* 7008.

Plantaginaceae

Plantago erosa Wall.
Way to Sinchu (D5), 1600 m, *Sikdar* 6914.

Nyctaginaceae

Boerhavia diffusa Linn.
Bhutanghat (D6), *Sikdar* 4089.

Amaranthaceae

Achyranthes aspera Linn.
Bhutanghat (D6), *Sikdar* 4090; South Rajabhatkhawa (D3), *Sikdar* 4272.

A. bidentata Bl.
Poro (D1), *Sikdar* 774.

Aerva sanguinolenta (Linn.) Bl.
Bhutanghat (D6), *Sikdar* 4141; Tobgaon (D5), 1200 m, *K. Biswas* 2045.

Alternanthera sessilis (Linn.) DC.
Cheko (D2), *Sikdar* 916; Poro (D1), *Sikdar* 753; Bhutanghat (D6), *Sikdar* 4095; Balapara (D7), *Sikdar* 4156.

Amaranthus spinosus Linn.
Garam (D2), *Sikdar* 855.

Celosia argentea Linn.
Moynabari (D6), *Sikdar* 4145; Balapara (D7), *Sikdar* 4231; 4234.

Cyathula prostrata (Linn.) Bl.
Poro (D1), *Sikdar* 773; Balapara (D7), *Sikdar* 4188; Tobgaon (D5), 1200 m, *K. Biswas* 3240.

Deeringia amaranthoides (Lamk.) Merr.
Poro (D1), *Sikdar* 825; Tashigaon (D5), 1100 m, *Sikdar* 4024; Bhutanghat (D6), 250 m, *Sikdar* 4107.

Basellaceae

Basella alba Linn.
Rajabhatkhawa (D3), *Sikdar* 7062.

Polygonaceae

Persicaria barbata (Linn.) Hara
North Bholka (D7), *Sikdar* 4152; Bhutanghat (D6), *V. Narayanswami* 3077; 3083.

P. capitata (Buch.-Ham.) H. Gross
Buxaduar (D5), 1200 m, *Sikdar* 956; 985; way to Sinchu (D5), 1400 m, *Sikdar* 4698; Buxa-Bhutan road (D5), 1200 m, *V. Narayanswami* 2541.

P. chinensis (Linn.) H. Gross
Poro (D1), *Sikdar* 751; Garam (D2), *Sikdar* 889; Balapara (D7), *Sikdar* 4166; South Rajabhatkhawa (D3), *Sikdar* 4254; Lapchakhawa (D5), *Sikdar* 965; Buxa to Bhutan-road (D5), 1000 m, *V. Narayanswami* 2495.

P. hydropiper (Linn.) Spach
South Bholka (D7), *Sikdar* 4238; South Rajabhatkhawa (D3), *Sikdar* 4245; Poro (D1), *Sikdar* 890; Buxa road (D3), *K. Biswas* 1613.

P. kawagoeana (Makino) Nakai
Balapara (D7), *Sikdar* 4162; Rajabhatkhawa (D3), *Sikdar* 7009; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2354; 2307; Rajabhatkhawa (D3), *C. R. Das* 10.

P. microcephala (D. Don) H. Gross
Buxa road (D3), *K. Biswas* 1687.

P. nepalensis (Meissn.) H. Gross
Poro (D1), *Sikdar* 790; Buxaduar (D5), 1200 m, *Sikdar* 953; Bhutanghat (D6), *Sikdar* 4078.

P. orientale (Linn.) Assenov.
Bhutanghat (D6), *V. Narayanswami* 3082.

P. posumbu (D. Don) H. Gross
Garam (D2), *Sikdar* 875; Poro (D1), *Sikdar* 779; Buxa near station (D3), *V. Narayanswami* 2872; Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2633; Rajabhatkhawa (D3), *V. Narayanswami* 2399.

P. pubescens (Bl.) Hara var. **acuminatum** (Franch. et Sav.) Hara
Poro (D1), *Sikdar* 799; Rajabhatkhawa (D3), *C. R. Das* 9.

P. runcinata (Buch.-Ham.) H. Gross
Ramiti (D5), 1400 m, *Sikdar* 4007; way to Ramiti (D5), 1250 m, *Sikdar* 6915.

P. strigosa (R. Br.) Nakai
Garam (D2), *Sikdar* 862; Chikoh (D2), *Sikdar* 914.

***P. viscosa** (Ham. ex. D. Don) Nakai
Rajabhatkhawa (D3), *C. R. Das* 11; Poro (D1), *B. Krishna* 496.

Polygonum assamicum Meissn.
Poro (D1), *Sikdar* 786.

P. barbatum Linn. var. **gracile** (Danser) Stewart
Bhutanghat (D6), *Sikdar* 4088.

Rumex nepalensis Spreng.
Sinchu (D5), 1600 m, *Sikdar* 6939.

R. trisetifer Stokes
Rajabhatkhawa (D3), *Sikdar* 7063; Rajabhatkhawa (D3), *C. R. Das* 12; Rajabhatkhawa depot road (D3), *V. Narayanswami* 2401.

Piperaceae

Peperomia heyneana Miq.
Way to Sinchu (D5), 1800 m, *Sikdar* 6956; Buxa to Chunabhati (D5), 1000 m, *V. Narayanswami* 2637; Buxa to Bhutan border (D5), 1800 m, *V. Narayanswami* 2750.

Piper chaba Hunter
21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2335.

P. diffusum Vahl
Buxa-Bhutan road (D5), 850 m, *V. Narayanswami* 2490.

P. gamblei C. DC.
Buxa-Bhutan road (D5), 1400 m, *V. Narayanswami* 2774.

P. griffithii C. DC.
Lapchakhawa (D5), *Sikdar* 949.

P. mullesua D. Don
Way to Sinchu (D5), 1500 m, *Sikdar* 4697.

P. pedicellosum Wall. ex C. DC.
Way to Raimatong (D5), 600 m, *Sikdar* 6931.

P. peepuloides Roxb.
Buxaduar (D5), 1000 m, *Sikdar* 937; Buxa to Tobgaon (D5), 1100 m, *Sikdar* 938; Buxaduar (D5), 950 m, *Sikdar* 4058; Tobgaon (D5), 1200 m, *V. Narayanswami* 2707.

P. trioicum Roxb.
Poro (D1), *Sikdar* 775; Garam (D2), *Sikdar* 897; Rajabhatkhawa (D3), *Sikdar* 7076.

Chloranthaceae

Chloranthus officinalis Bl.
Garam (D2), *Sikdar* 891; Poro (D1), *Sikdar* 823; Rajabhatkhawa (D3), *Sikdar* 7014; Rajabhatkhawa (D3), *K. Biswas* 1556; 1569; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2345.

Myristicaceae

***Knema erratica** (Hook. f. et Thoms.) J. Sinclair
Way to Buxaduar (D5), 600 m, *Sikdar* 4594.

K. linifolia (Roxb.) Warb.
Poro (D1), *Sikdar* 921.

Lauraceae

Cinnamomum glanduliferum (Wall.) Meissn.
Rajabhatkhawa (D3), *K. Biswas* 2222.

Litsea chartacea (Wall. ex Nees) Hook. f.
Way to Sinchu (D5), 1750 m, *Sikdar* 6949.

L. monopetala (Roxb.) Pers.
Rajabhatkhawa (D3), *V. Narayanswami* 2450; Poro (D1), *B. Krishna* 480.

Phoebe lanceolata (Wall. ex Nees) Nees
Tobgaon (D5), 1000 m to 1600 m, *K. Biswas* 2074.

Elaeagnaceae

Elaeagnus conferta Roxb.
North Bholka (D7), *Sikdar* 4179.

E. pyriformis Hook. f.
Buxaduar (D5), 800 m, *Sikdar* 4658; Rajabhatkhawa (D3), *K. Biswas* 1558.

LORANTHACEAE

Helixanthera ligustrina (Wall.) Danser
Chunabhati (D5), 1000 m, *Sikdar* 4654; 4664; Buxa N. W. (D5), 800 m, *V. Narayanswami* 2730.

Macrosolen cochinchinensis (Lour.) van Tiegh.
On way to Buxaduar (D5), 600 m, *K. Biswas* 1710; 1910; Rajabhatkhawa (D3), *C. R. Das* 38; Poro (D1), *B. Krishna* 483.

SANTALACEAE

Henslovia heterantha (Wall.) Hook. f. et Thoms. ex A. DC.
Tobgaon (D5), 1400 m, *V. Narayanswami* 2697; Buxa to Bhutan road (D5), 1000 m, *V. Narayanswami* 2762.

EUPHORBIACEAE

Baliospermum corymbiferum Hook. f.
Way to Buxaduar (D5), 700 m, *Sikdar* 4599.

B. montanum (Willd.) Muell.-Arg.
Bhutanghat (D6), 325 m, *Sikdar* 4093.

Bischofia javanica Bl.
Mahakalguri, Alipurduar (D3), *E. A. Heawood*, s.n.

Breynia rhamnoides (Retz.) Muell.-Arg.
South Rajabhatkhawa (D3), *Sikdar* 4269.

Bridelia monoica (Lour.) Merr.
Poro (D2), *Sikdar* 836; Central Raidak (D6), *Sikdar* 4139; South Rajabhatkhawa (D3), *Sikdar* 4259.

B. stipularis (Linn.) Bl.
Poro (D1), *Sikdar* 797; Central Raidak (D6), *Sikdar* 4138; North Bholka (D7), *Sikdar* 4170.

Claoxylon khasianum Hook. f.
Garopara, Rajabhatkhawa (D3), *C. R. Das* 90.

***C. longipetiolatum** Kurz
North Rajabhatkhawa (D3), *Sikdar* 6997.

C. polot (Burm. f.) Merr.
North Rajabhatkhawa (D3), *Sikdar* 7015.

Croton bonplandianus Baill
Rajabhatkhawa (D3), *Sikdar* 4585; Rajabhatkhawa towards Alipurduar (D3), *C. R. Das* 74.

Endospermum chinense Benth.
Rajabhatkhawa (D3), *V. Narayanswami* 2356.

Eriococcus hamiltonianus (Muell.-Arg.) Hurusawa et Tanaka
Buxaduar (D5), 850 m, *Sikdar* 4606; North Rajabhatkhawa (D3), *Sikdar* 6994; Buxa-Santrabari (D5), 700 m, *V. Narayanswami* 2932.

Euphorbia hirta Linn.
Poro (D1), *Sikdar* 780; Garam (D2), *Sikdar* 850.

E. pulcherrima Willd. ex Klotz.
Buxaduar (D5), 800 m, *Sikdar* 931.

Glochidion arborescens Bl.
Sinchu (D5), 1450 m, *Sikdar* 6904.

G. multiloculare Voigt
Poro (D1), *Sikdar* 832.

Hemicicca glauca (Muell.-Arg.) Hurusawa et Tanaka
Rajabhatkhawa (D3), *C. R. Das* 19.

Jatropha curcus Linn.
Buxaduar (D5), 850 m, *Sikdar* 4621.

Kirganelia reticulata (Poir.) Baill.
Buxaduar (D5), 650 m, *K. Biswas* 920.

Mallotus philippinensis (Lamk.) Muell.-Arg.
Damanpur (D2), *Sikdar* 919; Chunabhati (D5), 1100 m, *Sikdar* 4001; Balapara (D7), *Sikdar* 4160.

Manihot esculenta Crantz.
Buxaduar (D5), 850 m, *Sikdar* 4032.

***Ostodes paniculata** Bl.
Ramiti, Buxaduar (D5), 1400 m, *Sikdar* 4676; Buxa to Bhutan road (D5), 1200 m, *V. Narayanswami* 2572.

Phyllanthus urinaria Linn.
Garam (D2), *Sikdar* 872; Poro (D1), *Sikdar* 759; South Rajabhatkhawa (D3), *Sikdar* 4270,
Ricinus communis Linn.
Garam (D2), *Sikdar* 841.
Sauropus androgynus (Linn.) Merr.
Buxaduar (D5), 1000 m, *Sikdar* 977; Rajabhatkhawa Depot road (D5), *V. Narayanswami* 2441.
S. pubescens Hook. f.
Poro (D1), *Sikdar* 756.

URTICACEAE

Boehmeria hamiltoniana (Wall.) Wedd.
Lapchakhawa (D5), 1200 m, *Sikdar* 975.
B. macrophylla D. Don
Buxaduar (D5), 800 m, *K. Biswas* 1923.
B. malabarica (Wall.) Wedd.
Tobgaon (D5), 1600 m, *K. Biswas* 2066.
B. platyphylla D. Don
On way to Buxa road (D3), 600 m, *K. Biswas* 1905.
B. scabrella (Roxb.) Gaud.
Garam (D2), *Sikdar* 898.
B. ternifolia D. Don
Way to Sinchu (D5), 1800 m, *Sikdar* 6908.
Elatostema hookerianum Wedd.
On way to Sinchula, Bhutan border (D5), 1700 m, *K. Biswas* 1986.
E. lineolatum Wight
Way to Tobgaon (D5), 1100 m, *Sikdar* 4638; Tobgaon (D5), 1200 m, *K. Biswas* 2056.
E. platyphyllum Wedd.
Way to Tobgaon (D5), 1100 m, *Sikdar* 4644.
Girardinia zeylanica Decaisne
Tobgaon (D5), 1250 m, *K. Biswas* 2069.
Pilea scripta (Ham.) Wedd.
Garam (D2), *Sikdar* 846.
Pouzolzia indica var. **angustifolia** Wedd.
North Rajabhatkhawa (D3), *Sikdar* 7006.
P. zeylanica (Linn.) Benn.
Poro (D1), *Sikdar* 815; North Rajabhatkhawa (D3), *Sikdar* 7007; Garopara, Rajabhatkhawa (D3), *C. R. Das* 94; Mahakalguri, Alipurduar (D3), *E. A. Heawood* 6.
Urtica parviflora Roxb.
Buxaduar (D5), 750 m, *K. Biswas* 1921.

ULMACEAE

Holoptelea integrifolia (Roxb.) Planch.
Rajabhatkhawa, Jainti river beds (D3), *Sikdar* 8115.

CANNABINACEAE

Cannabis sativa Linn.
Rajabhatkhawa (D3), *Sikdar* 7012.

MORACEAE

Artocarpus chaplasha Roxb.
Way to Buxaduar (D5), 1000 m, *K. Biswas* 1757.
A. lakoocha Roxb.
Buxa road (D3), *K. Biswas* 1636.
Ficus auriculata Lour.
Chunabhati (D5), 1000 m, *Sikdar* 4662.
F. benghalensis Linn.
Buxaduar (D5), 800 m, *Sikdar* 6927.
F. curtipes Corner
Balapara (D7), *Sikdar* 4201; Buxa road (D3), *K. Biswas* 1665.
F. hirta Vahl
Poro (D1), *B. Krishna* 485.
F. prostrata Wall. ex Miq.
Buxaduar (D5), 800 m, *K. Biswas* 1767.
Maclura cochinchinensis (Lour.) Corner
Rajabhatkhawa (D3), *V. Narayanswami* 2404; Damanpur (D2), *C. R. Das* 54.
Streblus asper Lour.
Poro (D1), *B. Krishna* 456.

Fagaceae

Quercus lanceaefolia Roxb.
Poro (D1), *Sikdar* 835; Garam (D2), *Sikdar* 893.

Salicaceae

Salix tetrasperma Roxb.
Garam (D2), *Sikdar* 886; North Bholka (D7), *Sikdar* 4176.

MONOCOTYLEDONS

Hydrocharitaceae

Nechamandra alternifolia (Roxb.) Thwait.
Rajabhatkhawa (D3), *Sikdar* 7205.

Orchidaceae

***Ascocentrum micranthum** (Lindl.) Holtt.
Buxaduar (D5), 850 m, *Sikdar* 4665; Buxa to Bhutan road (D5), 1150 m, *V. Narayanswami* 2647.

Clenogyne dichotoma Salisb.
Near poro rest house (D1), *B. Krishna* 493.

Coelogyne ochracea Lindl.
Way to Sinchu (D5), 1650 m, *Sikdar* 6919; Buxa to Bhutan road (D5), 1600 m, *V. Narayanswami* 2548; 2754.

Dendrobium formosum Roxb.
North Rajabhatkhawa (D3), *Sikdar* 7221.

D. moschatum (Buch.-Ham.) Wall.
Way to Santrabari (D5), *Sikdar* 8112; Buxa to Chunabhati (D5), 1100 m, *V. Narayanswami* 2618.

D. pierardi Roxb.
Poro (D1), *B. Krishna* 499.

Eria flava Lindl.
Buxaduar (D5), 850 m, *Sikdar* 6906; Buxa to Bhutan road (D5), 1200 m, *V. Narayanswami* 2529.

Luisia brachystachys Bl.
North Rajabhatkhawa (D3), *Sikdar* 6999.

***Pholidota articulata** Lindl. var. **griffithii** (Hook. f.) King & Pantl.
Way to Buxaduar (D5), 750 m, *Sikdar* 4615; Buxa to Bhutan road (D5), 1200 m, *V. Narayanswami* 2559; Tobgaon (D5), 1400 m, *V. Narayanswami* 2709; 2731.

P. imbricata (Roxb.) Lindl.
Buxaduar (D5), 800 m, *Sikdar* 4669; Buxa to Bhutan road (D5), 1100 m, *V. Narayanswami* 2539; 2753.

Rhynchostylis retusa (Linn.) Bl.
Tashigaon (D5), 1200 m, *Sikdar* 6905; Buxaduar (D5), 1100 m, *Sikdar* 1819.

Zingiberaceae

Alpinia malaccensis (Burm. f.) Rosc.
North Rajabhatkhawa (D3), *Sikdar* 7004; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2359.

Musaceae

Musa paradisiaca Linn.
Raimatong (D5), 600 m, *Sikdar* 7091.

Amaryllidaceae

Zephyranthes tubispatha Herb.
Buxaduar (D5), 800 m, *Sikdar* 4617.

Hypoxidaceae

Curculigo orchioides Gaertn.
Bhutanghat (D6), *V. Narayanswami* 3107.

Liliaceae

Alium cepa Linn.
Rajabhatkhawa (D3), *Sikdar* 7085.

Asparagus racemosus Willd.
Bhutanghat (D6), *Sikdar* 4092.

Pontederiaceae

Monochoria hastata (Linn.) Solms.
Poro (D1), *B. Krishna* 463.

Commelinaceae

Floscopa scandens Lour.
Poro (D1), *Sikdar* 811; North Bholka (D7), *Sikdar* 4153.

Arecaceae (=Palmae)

Calamus leptospadix Griff.
Rajabhatkhawa (D3), *Sikdar* 7239; Damanpur (D2), *Sikdar* 7217.
C. tenuis Roxb.
Damanpur (D2), *Sikdar* 7221.
C. viminalis Willd. var. **fasciculata** Becc. ex Hook. f.
Rajabhatkhawa (D3), *Sikdar* 7154.
Caryota urens Linn.
Buxaduar forest (D5), 800 m, *Sikdar* 7189.
Wallichia densiflora Mart.
Raimatong (D5), *S. K. Mukerjee* 1395.

Pandanaceae

Pandanus furcatus Roxb.
Buxaduar to Santrabari (D5), 650 m, *Sikdar* 6933.

Araceae

Amorphophallus campanulatus (Roxb.) Bl. ex Decne
Bhutanghat (D6), *Sikdar* 4122.
Pothos scandens Linn.
North Rajabhatkhawa (D3), *Sikdar* 7016; Rajabhatkhawa (D3), *V. Narayanswami* 2407.

Smilacaceae

Smilax lancaefolia Roxb.
Way to Sinchu (D5), 1650 m, *Sikdar* 6959; Buxa to Santrabari (D5), 700 m, *V. Narayanswami* 2857.

Potamogetonaceae

Potamogeton crispus Linn.
South Bholka (D7), *Sikdar* 4212.

Cyperaceae

Carex stramentitia Boott ex Bockeler
Buxa road (D3), *K. Biswas* 1645 (5 sheets); Near Buxaduar (D5), *K. Biswas* 2037 (5 sheets).
Cyperus brevifolius (Rottbl.) Hassk.
North Rajabhatkhawa (D3), *Sikdar* 7013.
C. iria Linn.
Way to Buxaduar (D5), 550 m, *Sikdar* 7025; Buxa-Santrabari (D5), 300 m, *V. Narayanswami* 2908.
Fimbristylis aestivalis (Retz.) Vahl
Rajabhatkhawa (D3), *V. Narayanswami* 2485; Rajabhatkhawa (D3), *C. R. Das* 5.
F. dichotoma (Linn.) Vahl
Rajabhatkhawa (D3), *C. R. Das* 97.
***Pycreus stramineus** C. B. Clarke
Near Buxaduar (D5), *K. Biswas* 2037.

Poaceae (= Gramineae)

Acroceras zizanioides (H.B.K.) Dandy
Garam (D2), *Sikdar* 899.
Axonopus compressus (Sw.) P. Beauv.
Buxa-Santrabari (D5), 200 m, *V. Narayanswami* 2940.
Brachiaria ramosa (Linn.) Stapf
Rajabhatkhawa (D3), *Sikdar* 7187.
B. reptans (Linn.) Gard. et Hubbard
Bhutanghat (D6), *V. Narayanswami* 3094.
Capillipedium assimile (Steud.) A. Camus
Bhutanghat (D6), *V. Narayanswami* 3068.
Chloris dolichostachya Lagasca
Bhutanghat (D6), *V. Narayanswami* 3018.
Cyrtococcum accrescens (Trin.) Stapf
Bhutanghat (D6), *V. Narayanswami* 3104.

C. patens (Linn.) A. Camus
Rajabhatkhawa (D3), *Sikdar* 7138; Buxa-Santrabari (D5), 350 m, *V. Narayanswami* 2910.

Dichanthium annulatum (Forssk.) Stapf
Buxa prison (D5), 800 m, *V. Narayanswami* 2980.

Digitaria longiflora (Retz.) Pers.
North Rajabhatkhawa (D3), *Sikdar* 7073.

D. sanguinalis (Linn.) Scop.
Rajabhatkhawa Depot road (D3), *V. Narayanswami* 2451; 2484.

Echinochloa colonum (Linn.) Link.
Balapara (D7), *Sikdar* 4181; Bhutanghat (D6), *V. Narayanswami* 3111.

Eleusine coracana (Linn.) Gaertn.
Garam (D2), *Sikdar* 878; 879.

Eragrostis coarctata Stapf
Rajabhatkhawa (D3), *Sikdar* 7048.

E. diarrhena (Schult.) Steud.
North Rajabhatkhawa (D3), *Sikdar* 7071.

E. nigra Nees ex Steud.
Buxa-Bhutan road, 36th mile (D5), 1200 m, *V. Narayanswami* 2562.

E. pilosa (Linn.) P. Beauv.
North Rajabhatkhawa (D3), *Sikdar* 7072.

E. tenella (Linn.) P. Beauv. ex Roem. et Schult.
Rajabhatkhawa (D3), *Sikdar* 7070.

Eriochloa procera (Retz.) C. E. Hubb.
Bhutanghat (D6), *V. Narayanswami* 3087.

Eulalia trispicata (Schult.) Henr.
Rajabhatkhawa (D3), *K. Biswas* 1560.

Hemarthria compressa (Linn. f.) R. Br.
North Rajabhatkhawa (D3), *Sikdar* 7000.

Microstegium vagans (Nees ex Steud.) A. Camus
Garam (D2), *Sikdar* 863.

Neyraudia arundinacea (Linn.) Hiern.
Buxa road (D3), *K. Biswas* 1679.

N. reynaudiana (Kunth) Keng ex Hitchc.
Bhutanghat (D6), 350 m, *Sikdar* 4120.

Oplismenus burmanii (Retz.) P. Beauv.
Bhutanghat (D5), 300 m, *Sikdar* 4116.

Ottochloa nodosa (Kunth) Dandy
Bhutanghat (D6), *V. Narayanswami* 3108.

Panicum notatum Retz.
Poro (D1), *Sikdar* 798; Rajabhatkhawa (D3), *K. Biswas* 1562.

P. paludosum Roxb.
North Rajabhatkhawa (D3), *Sikdar* 7074.

P. repens Linn.
Bhutanghat (D6), *V. Narayanswami* 3087.

Paspalum scrobiculatum Linn.
Buxa-Bhutan road, 36th mile (D5), 1200 m, *V. Narayanswami* 2554; Bhutanghat (D6), *V. Narayanswami* 3075.

Poa annua Linn.
Sinchu, near Bhutan (D5), 1800 m, *Sikdar* 6918.

Pogonatherum crinitum (Thunb.) Kunth
Jainti Dak bunglow (D4), *V. Narayanswami* 3004; Rajabhatkhawa (D3), *C. R. Das* 103.

Polytoca digitata (Linn. f.) Druce
Bhutanghat (D6), *V. Narayanswami* 3109.

Sacciolepis indica (Linn.) A. Chase
Rajabhatkhawa (D3), *C. R. Das* 7; 21 miles from Rajabhatkhawa (D3), *V. Narayanswami* 2365.

Setaria glauca (Linn.) P. Beauv.
Santrabari (D5), 200 m, *V. Narayanswami* 2904; Buxa-Santrabari (D5), 250 m, *V. Narayanswami* 2936.

Sorghum halepense (Linn.) Pers.
Poro (D1), *Sikdar* 776.

Sporobolus diander (Retz.) P. Beauv.
South Rajabhatkhawa (D3), *Sikdar* 4271; Alipurduar (D3), *C. R. Das* 78; Buxa-santrabari (D5), 200 m, *V. Narayanswami* 2917.

S. fertilis (Steud.) W.D. Calayton
Rajabhatkhawa (D3), *Sikdar* 7047; 21 miles road from Rajabhatkhawa (D3), *V. Narayanswami* 2349.

Themeda caudata (Nees) A. Camus
South Bholka (D7), *Sikdar* 4198.

Zea mays Linn.
Rajabhatkhawa (D3), *Sikdar* 4602; Rajabhatkhawa depot road (D3), *V. Narayanswami* 2457.

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One of us (J. K. Sikdar) wishes to express his deep sense of gratitude to Prof. R. S. Rao, Andhra University, Waltair (ex Jt. Director-in-Charge, Botanical Survey of India) for his constant help and guidance during the work at the Central National Herbarium, Howrah. Sincere thanks are due to Director, Botanical Survey of India for the award of Junior Research Fellowship to one of us (J. K. Sikdar) during the period of which this work has been carried out and to Deputy Director, Central National Herbarium, Howrah for the facilities to work in the herbarium.

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NEW DESCRIPTIONS

A NEW SPECIES OF *SONCHUS* L. (ASTERACEAE) FROM SOUTH INDIA[1]

M. CHANDRABOSE, V. CHANDRASEKARAN AND N. C. NAIR[2]

(*With seven text-figures*)

Sonchus jainii sp. nov.

Herbae erectae, 30-75 cm altae, glabrae; radices at caules laticibus lacteis. Folia 2-16 x 1.0-4.5 cm, spiralia, approximata in parte inferiore, remota in parte superiore; folia infera anguste oblonga, sinuate lobata vel pinnatifida segmentis ovato-acutis vel oblongo-obtusis, interdum simplicia, glabra, recurvata secus margines, ad apices acuta, ad bases auriculata; folia supera simplicia, ovato-lanceolata, subintegra, recurvata secus margines, glabra, ad apices acuta vel acuminata, ad bases amplexicaulia auriculis acutis. Inflorescentia terminalis capitulis racemose fasciculata vel paniculata. Capitula ± 1.7-2.0 cm longa, 1.5-2.0 cm diametris, lutea, campanulata, homogama floribus totis ligulatis, pedunculata; torus parum depressum. Bracteae involucri 6-15 x 2.5-4.0 mm, multiseriatae, coriaceae, glabrae praeter apicem aliquot pilis, obtuse acuminatae; bracteae involucri externae gradatim breviores, ovatae vel ovate-lanceolatae; bracteae involucri interiores longiores, oblongo-lanceolatae. Flores lutei, hermaphroditi. Tubus corollae 6-7 mm longus, linearis, fauce extra sparsim pubescenti; limbus 6-7 x 2 mm, anguste oblongus, apice 5-dentato, dentes ± 0.5 x 0.3 mm. Antherae ± 2.5 mm longae, lineari-oblongae, connatae; fila ± 1 mm longa, libra, glabra. Ovarium ± 1.5 x 0.9 mm, lineari-oblongum, costatum extremis umbabus truncatis, glabrum; stylus ± 1 cm longus, linearis, glaber praeter prope apicem; stigma bifidus, brachia ± 1.7 mm longa simplicia. Pappus 8-10 mm longus, candidus, leviter heteromorphus pilis crassis et subtiliter capillaceis. Achenia ± 5 x 1 mm, brunnea, lineari-oblonga, compressa, valde 4-costata nervis duabus longitudinalibus intermediis inconspicuis, levia, glabra. (Figs. 1-7).

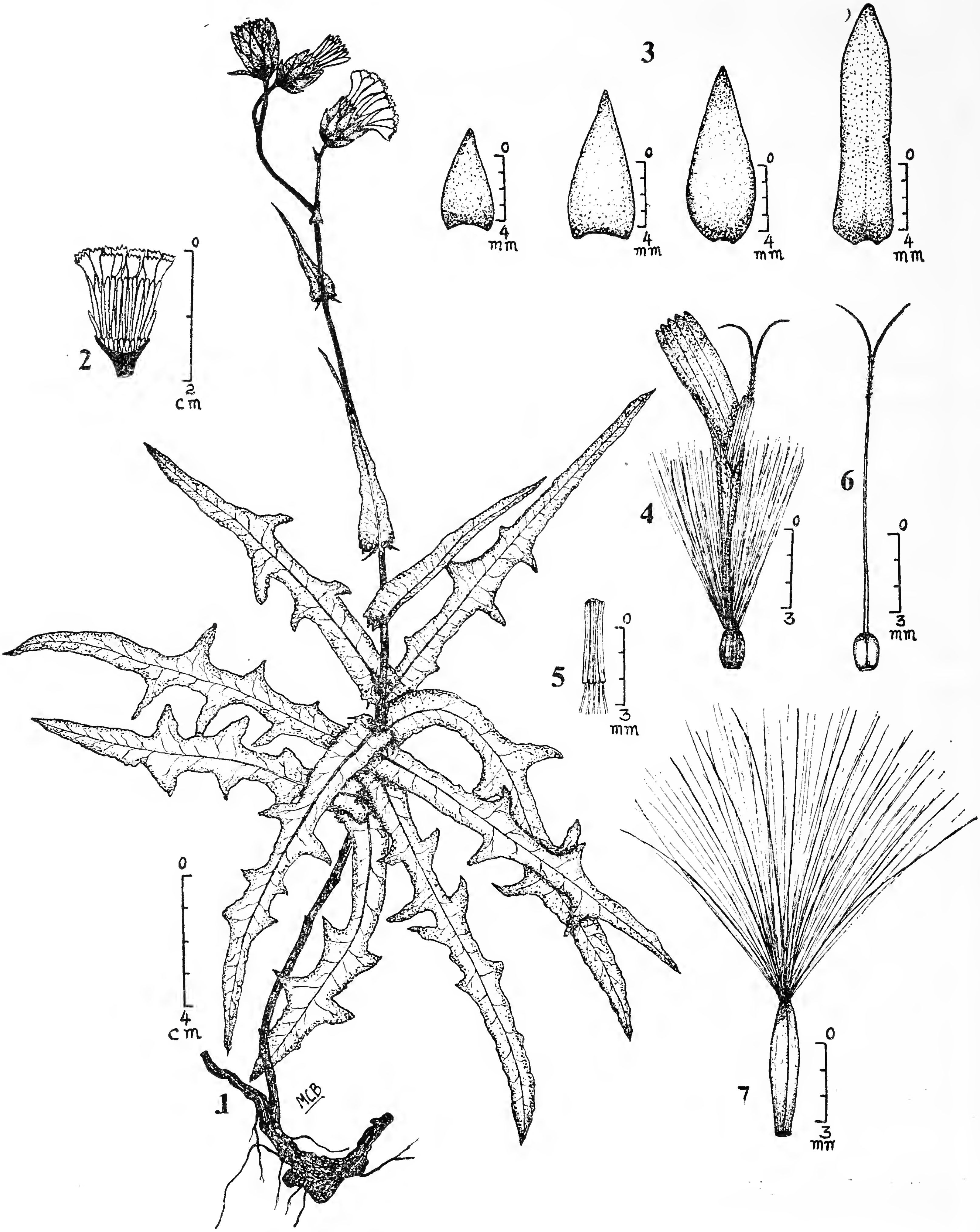
Holotypus *Chandrabose* 69015 (CAL) et isotypi *Chandrabose* 69015 (MH. Acc. Nos. 117706, 117707, 117708, 117709, 117710, 117711) lecti apud Konalar, Anamalai, Dist. Coimbatore in statu Tamil Nadu die 18-11-1980.

Sonchus jainii sp. nov.

Erect herbs 30-75 cm high, glabrous; roots and stems with milky latex. Leaves 2-16 x 1-4.5 cm, in spirals, close in the lower portion, distant above; lower ones narrowly oblong, sinuately lobed or pinnatifid with ovate-acute or oblong-obtuse segments, sometimes simple, recurved along the margins, glabrous, acute at apex, auricled at base; upper ones simple, ovate-lanceolate, subentire, recurved along the margins, glabrous, acute or acuminate at apex, amplexicaul at base with acute auricles. Heads ± 1.7-2 cm long, 1.5-2 cm across, yellow,

[1] Accepted October 1982.

[2] Botanical Survey of India, Coimbatore-641 003.



Figs. 1-7: *Sonchus jainii* sp. nov.
1. Plant. 2. L. S. of Head. 3. Involucral bracts. 4. Ligulate flower. 5. Androecium. 6. Gynoecium. 7. Achenes with pappus hairs.

campanulate, homogamous with all ligulate flowers, pedunculate, in terminal fascicled racemes or panicles; torus slightly depressed. Involucral bracts 6-15 x 2.5-4 mm, many-seriate, coriaceous, glabrous excepting a few hairs at the tip, obtusely acuminate; outer ones gradually shorter, ovate or ovate-lanceolate; inner ones longer, oblong-lanceolate. Flowers yellow, bisexual. Corolla tube 6-7 mm long, linear, sparsely pubescent at throat without; limb 6-7 x 2 mm, narrowly oblong, 5-toothed at apex, teeth $\pm$ 0.5 x 0.3 mm. Anthers $\pm$ 2.5 mm long, linear-oblong, connate; filaments $\pm$ 1 mm long, free, glabrous. Ovary $\pm$ 1.5 x 0.9 mm, linear-oblong, ribbed, truncate at both ends, glabrous; style $\pm$ 1 cm long, linear, glabrous except near the tip; stigma bifid, arms $\pm$ 1.7 mm long, simple. Pappus 8-10 mm long, dull-white, smooth, faintly heteromorphic with thick and finer capillaceous hairs. Achenes $\pm$ 5 x 1 mm, brown, linear-oblong, compressed, strongly 4-ribbed with 2 faint longitudinal nerves in between, smooth, glabrous. (Figs. 1-7).

The holotype *Chandrabose* 69015 (CAL) and isotypes *Chandrabose* 69015 (MH. Acc. Nos. 117706, 117707, 117708, 117709, 117710, 117711) were collected in Konalar, Anamalai, Coimbatore District, Tamil Nadu on 18-11-1980.

This interesting taxon obviously represents a member of the tribe Lactuceae (Syn.: Cichorieae), but we found it difficult to place our new species in the appropriate genus, as this perennial species exhibits: achenes longer, narrowed at both ends; and pappus of finer capillaceous smooth hairs intermixed with thick smooth hairs. F. G. Davies after examining the specimen remarked, "..... It does seem to be near *Sonchus,* and at present I would not be certain whether it belongs in this genus or not. There are some rather odd perennial *Sonchus* species and it may be a new one of these". We, however, treat it as a species of *Sonchus* L. as suggested by F. G. Davies of the Kew Herbarium.

This species grows on the grassy slopes at an altitude of about 2050 m. This species is named in honour of Dr. S. K. Jain, Director, Botanical Survey of India, Howrah for his contributions to the taxonomy of Indian plants.

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DESCRIPTION OF TWO NEW SPECIES AND ONE NEW RECORD OF CRYPTOSTIGMATID MITES (ACARI: ORIBATEI) FROM MAHARASHTRA, INDIA[1]

A. K. SANYAL[2]

(*With four text-figures*)

INTRODUCTION

During the course of studies on the oribatid mite fauna of Maharashtra two new species

[1] Accepted December 1982.

[2] Zoological Survey of India, 14, Madan Street, Calcutta-700 072, India.

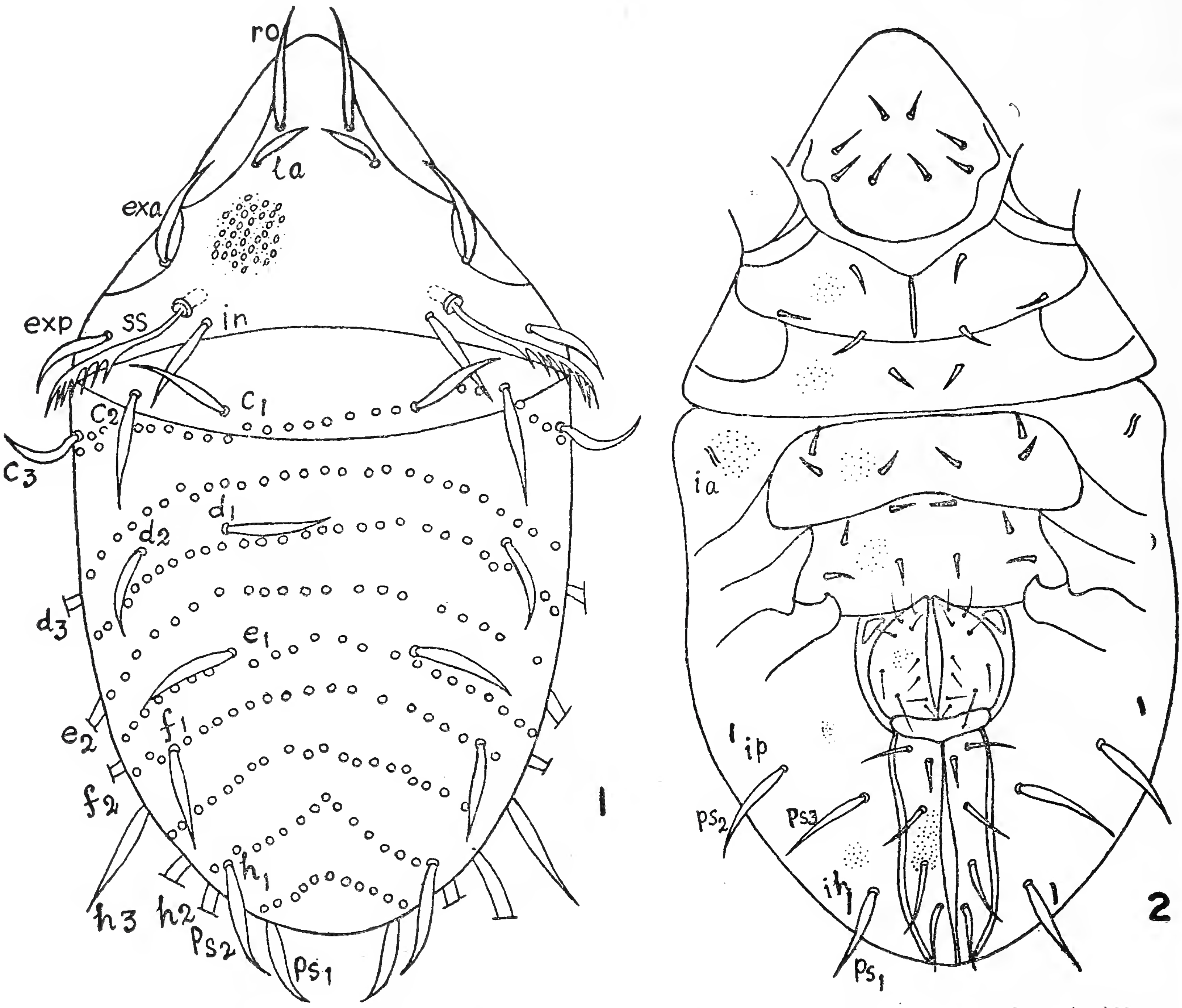
namely, *Haplacarus bhadurii* and *H. maharashtraensis* and one species namely *Javacarus kuhnelti* as new for the state were recorded and are described in this paper. The specimens were collected by me and are deposited in the Zoological Survey of India, Calcutta.

Family Lohmaniidae

Haplacarus bhadurii sp. nov.

(Figs. 1-2)

Colour of the body and legs yellowish brown; length of the body 667 μ, width 333 μ. The body is covered with a fine transparent cerotegument ornamented with a microsculpture of knob-like refractive papillae arranged in rows. These papillae are absent from the prodorsum, from the ventral plates and from dorsal surfaces of the legs. The integument beneath the cerotegument bears a fine microsculpture of regular punctations; this is clearly seen on parts of the body where the papillate microsculpture is lacking on the cerotegument.



Haplacarus bhadurii sp. nov. Fig. 1. Dorsum. Fig. 2. Venter.
(Length 667 μ)

Dorsal and ventral views of the holotype are given in Figs. 1 and 2.

Prodorsum: Prodorsum finely foveolated; rostral tectum is entire, not incised. Lateral margins of prodorsum have an angular contour. Rostral setae inserted close together on dorsal surface of rostrum, 2-3 times longer than their mutual distance. All prodorsal setae markedly foliate, smooth; rostral, lamellar, interlamellar and posterior exo-pseudostigmatic setae measure 69-86 μ long; anterior exo-pseudostigmatic setae slightly longer, measuring 103 μ. Sensillus pectinate with 7 branches. Slightly broad prodorsal transverse band posterior to the pseudostigmatic region.

Notogaster: Notogaster bears 9 rows of papillae, interpapillar region of notogaster covered by fine microsculpture of punctations. The arrangement of these papillae shows a striking resemblance to the description of *Javacarus kuhnelti* Balogh, 1961. There are 32 notogastral setae, neotrichy absent, all setae markedly foliate and smooth. The setae measure 69-103 μ; tips of the setae ps_1 strongly curved inwards.

Gnathosoma: Infracapitulum with 4 pairs of setae comprising a, m_1, m_2 and h; smooth, not markedly foliate.

Ventral region of podosoma: Coxisternal setal formula 3-1-3-4, setae smooth, not markedly foliate, arranged in usual manner as shown in Fig. 2.

Genito-anal region: Distinct aggenital plate, triangular, located at the anterolateral margins of the genital plates; genital plates undivided, no transverse suture, each with 10 setae comprising 4 antiaxial and 6 paraxial. Broadly rectangular pre-anal plate, much wider than long. Adanal-anal plates fused, no longitudinal suture, adanal-anal setal formula: 4-1, adanal setae slightly foliate, anal setae shorter and more slender than adanals; posterior adanal seta longer and tips not curved inward; fissures *ia*, *ip* and *ih* seen on ventral view as narrow slits.

Leg: All tarsi monodactyle.

Holotype: Adult ♀ INDIA: Maharashtra, Buldana, Rajur, 8.i.1982, ex soil with decomposed leaves.

Paratype: 1 ♀ same data as for holotype.

Remarks: The new species is closely related to *Haplacarus foliatus* Wallwork, 1962 but strongly differs from it in the arrangement of the knob like papillae on notogaster, having sensilla with less number of branches, shorter *in*, micro-punctations and also in having straight tips of posterior adanal seta.

The species is named in honour of Dr. A. K. Bhaduri, an oribatologist.

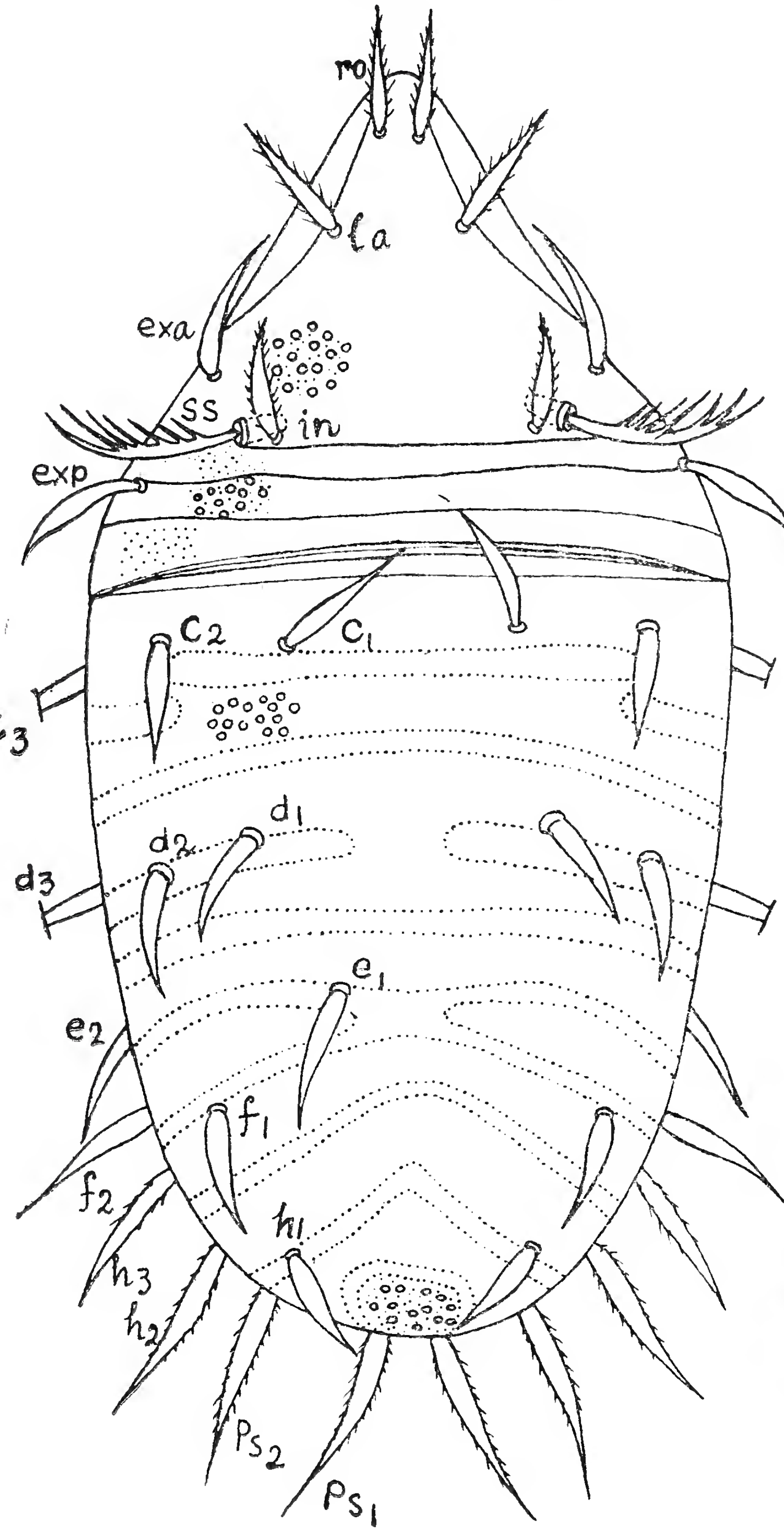
Haplacarus maharashtraensis sp. nov.
(Figs. 3-4)

Colour of the body and legs yellowish brown; length of the body 632 μ, width 316 μ. The body is covered with a fine transparent cerotegument beautifully ornamented with a microsculpture of regularly arranged knob-like refractive papillae. The microsculpture is absent from the prodorsal and notogastral transverse bands, from antiaxial margins of ventral plates and from dorsal surfaces of the legs. The integument beneath the cerotegument bears a fine microsculpture of regular punctations, this punctation is clear where the refractive papillae are absent. Dorsal and ventral views of the holotype are given in Figs. 3 and 4.

Prodorsum: Rostral tectum is entire not incised. Lateral margins of prodorsum have an angular contour. Rostral setae inserted close together on dorsal surface of rostrum, about 3 times longer than their mutual distance. All prodorsal setae are markedly foliate and bear small barbs except anterior exo-pseudostigmatic and posterior exo-pseudostig-

matic setae; length of the prodorsal setae varies from 57-92 μ, sensillus is pectinate with 7 branches; broad prodorsal transverse band posterior to the pseudostigmatic region.

Notogaster: There are 32 notogastral setae; neotrichy absent; all setae markedly foliate, h_2, h_3, ps_1, ps_2 and ps_3 with fine barbs, other setae smooth. The setae measure 60-115 μ; setae ps_1 rather thicker than the remaining. Notogaster bears 10 transverse bands, which are represented by clear bands of the cerotegument devoid of papillae.



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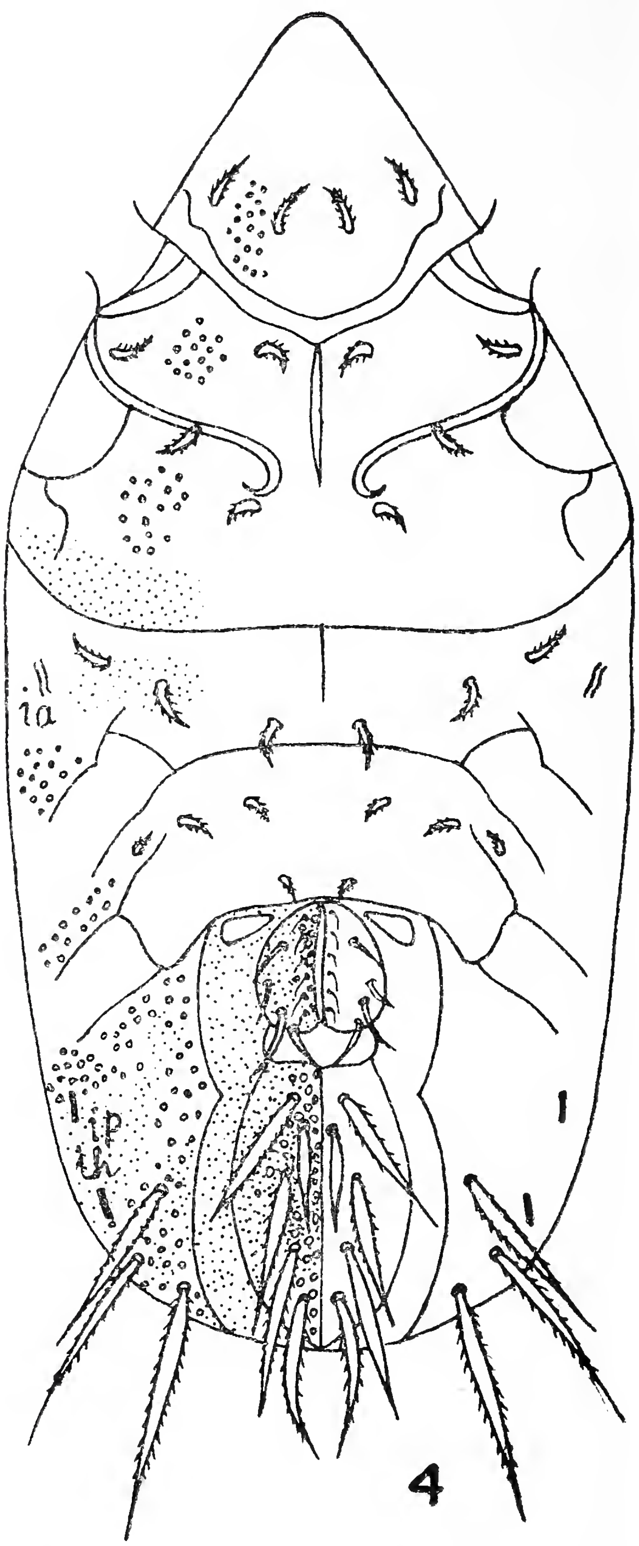

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Haplacarus maharashtraensis sp. nov. Fig. 3. Dorsum. Fig. 4. Venter. (Length 632 μ)

Gnathosoma: Infracapitulum with 2 pairs of setae, short, not moderately foliate, finely barbed.

Ventral region of podosoma: Coxisternal setal formula: 3-1-3-4, finely barbed, not markedly foliate, arranged in usual manner as shown in Fig. 4.

Genito-anal region: Aggenital plates distinct, triangular, located at the anterolateral margins of the genital plates, genital plates undivided, no transverse suture, each with 10 setae comprising 4 antiaxial and 6 paraxial. Preanal plate rectangular, much wider than long. Adanal-anal plates fused, no longitudinal suture, adanal-anal setal formula: 4-1, adanal setae long, finely barbed; anal setae more slender and shorter than adanals; posterior adanal setae longer and with strongly incurved tip; fissures *ia, ip,* and *ih* seen on ventral view as narrow slits.

Leg: All tarsi monodactyle.

Holotype: Adult ♀, INDIA: Maharashtra, Buldana, Rajur, 8.i.1982, ex soil with decomposed leaves.

Paratype: 1 ♀, same data as for holotype.

Remarks: The species is closely related to *Haplacarus foliatus* Wallwork, 1962 but differs sharply in the presence of barbed setae on notogaster and ventral plate, sensilla with less number of branches, difference in the shape of the notogastral bands and 2 pairs of barbed setae on infracapitulum.

KEY TO THE INDIAN SPECIES OF *Haplacarus*

1. Notogastral papillae arranged in rows; all setae smooth; posterior adanal setae without incurved tips .... *bhadurii* sp. nov.
— Notogastral papillae regularly distributed and form distinct bands; setae smooth or barbed; posterior adanal setae with strongly curved inward tips........................2
2. Setae barbed ....*maharashtraensis* sp. nov.
— Setae smooth ....*foliatus bengalensis* Bhattacharya *et al.*

Javacarus kuhnelti Balogh

Javacarus kuhnelti Balogh, 1961, *Acta. Zool. Acad. Sci. Hungarici, 7*: 19-44.

Javacarus kuhnelti, Bhattacharya *et al.*, 1974, *Oriental Ins., 8*(3): 286.

Javacarus kuhnelti, Mishra *et al.*, 1980, *Sci. & Cult., 46*: 225.

Material examined: 3 adult ♀♀, INDIA: Maharashtra, Buldana, Gondhankhera, 10.i. 1982, ex soil with decomposed leaves.

Remarks: The material from Maharashtra agrees with the drawings and descriptions of *Javacarus kuhnelti* Balogh, 1961 except in the length of the body which is slightly larger in the present specimens.

ACKNOWLEDGEMENTS

I am grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, for facilities. Sincere thanks are also due to Dr. S. K. Bhattacharyya and Dr. S. K. Gupta, Arachnology Division, Zoological Survey of India, for encouragement.

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A NEW SPECIES OF *OPHIORRHIZA* (RUBIACEAE) FROM ANDHRA PRADESH[1]

G. V. SUBBA RAO AND G. R. KUMARI[2]

(*With six text-figures*)

Ophiorrhiza chandrasekharanii sp. nov.

Ophiorrhiza fasciculata D. Don affinis, sed foliis parvioribus; pagina supera folii sparsim scabra; petiolis brevioribus; stipulis brevioribus et angustioribus; pedunculis brevioribus, fulvotomentosis; bracteolis paucioribus, multo brevioribus, sparsim pubentibus, differt.

This species is allied to *Ophiorrhiza fasciculata* D. Don but differs from it in having smaller leaves; sparsely scabrous upper leaf surface; much shorter petioles; shorter and narrower stipules; shorter fulvous tomentose peduncles; fewer, much shorter and sparsely pubescent bracteoles.

Herbs up to 32 cm tall; stems pubescent, more so towards upper region. Leaves up to 11.2 x 4.6 cm, oblong, oblong-lanceolate or ovate, membranous, scabrous above, glaucous beneath, pubescent on nerves, shortly acuminate, narrowed at base, margins shortly ciliate; petioles up to 1.5 cm long, tomentose; stipules up to 11 x 3 mm, narrowly deltoid, acuminate, pubescent. Flowers white, yellow on drying, faintly scented, in axillary and terminal fulvous tomentose corymbs or subcorymbs up to 5 cm across; peduncles up to 4.5 cm long, fulvous tomentose; bracteoles up to 4 mm long, few, persistent, narrow, acute, pubescent, ciliate, midrib obscure. Calyx: tube up to 2 mm long, fulvous tomentose; lobes up to 1.5 mm long, narrow, acute, pubescent, persistent. Corolla ribbed, pubescent without, glabrous within up to 1 mm from base, the rest crispate pubescent within with a row of long white hairs bordering the glabrous portion; tube up to 9 mm long; lobes up to 2 mm long, acute. Stamens 5, epipetalous, included, attached at about the middle of the glabrous portion of corolla tube; anthers up to 2 mm long; filaments 1.5 mm long, glabrous. Disc epigynous, of 2 large lobes, minutely glandular. Ovary 2 loculed, ovules many on basal ascending placentas; style 2 mm long; stigma 1.5 mm long, narrowly lanceolate, acute, 2 lobed; lobes connate. Capsules up to 8 x 3 mm, obcordate, compressed, patently pubescent, girt by calyx limb. Seeds many, minute, angled.

The holotype *Subba rao* 30049 (CAL), isotypes *Subba rao* 30049 (MH) were collected at Vankachinta, Visakhapatnam District, Andhra Pradesh on 1st June, 1968.

The specific epithet is in honour of Dr. N. Chandrasekharan Nair, Joint Director, Botanical Survey of India, Southern Circle, Coimbatore for his keen interest in the work on Flora of Visakhapatnam District and his contribution to the taxonomy of Indian plants.

ACKNOWLEDGEMENTS

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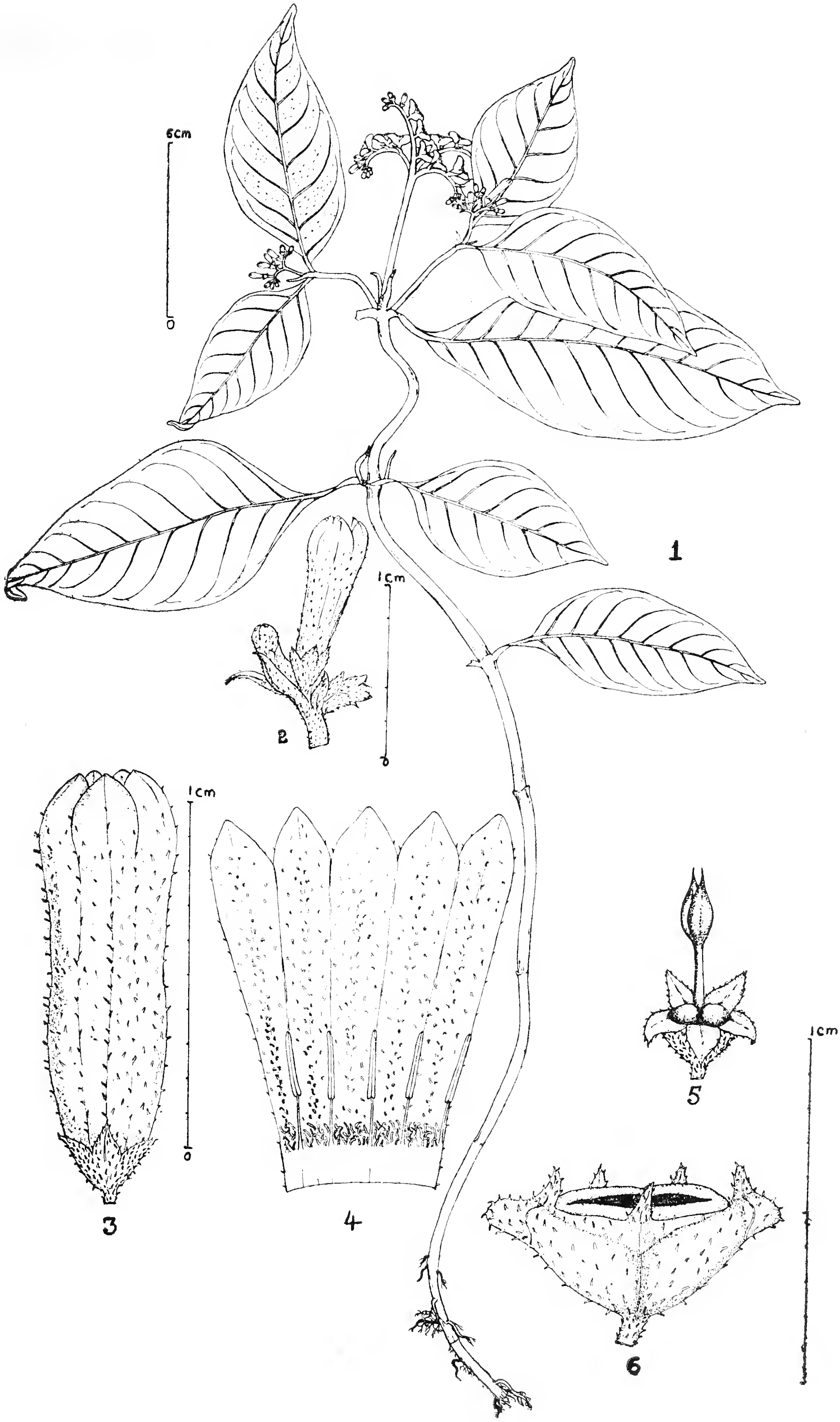
[1] Accepted December 1982.

[2] Botanical Survey of India, Coimbatore-461 003.



Figs 1-6. *Ophiorrhiza chandrasekharanii* sp. nov.
1. Plant. 2. A part of the inflorescence. 3. Flower. 4. Corolla split open.
5. Gynoecium. 6. Fruit.

ment and to Dr. A. N. Henry, Regional Botanist, Southern Circle, Botanical Survey of India, Coimbatore for helpful suggestions and discussion.

DESCRIPTION OF A NEW GENUS AND SOME NEW SPECIES OF TORRENTICOLE DIPTERA OF THE NORTHWEST HIMALAYA[1]

B. K. KAUL[2]

(*With thirty-four text-figures*)

Beasomia sexdecima, gen. *et* sp. nov. (Diptera: Psychodidae) and *Blepharocera alhnicola* sp. nov. and *B. rahlaea* sp. nov. (Diptera: Blepharoceridae) are described. The type specimens are deposited in the collection of the School of Entomology, St. John's College, Agra, U.P. India for onward transmission to Zoological Survey of India, Calcutta.

Genus **Beasomia** gen. nov.

MALE: Head transverse oval; antenna with 15 segments; first segment cordately oval with dense lamellae of long setae, third segment with a ventral pectinal brush of short conspicuous row of setae and two modified apical spines; flagellar segments without 'S' shaped chaetae. Palpus four segmented nearly equal to the length of antenna. Third longitudinal vein ending below wing tip; tip of wing pointed. Rs with four branches; distal part of Cu elongate. Sc reduced, wing base normal not disproportionately rounded or distended. Genitalia with three pairs of appendages. Female antenna 16 segmented. The affinity of this new genus to other known genera is shown in the following key.

Subfamily PSYCHODINAE
KEY TO GENERA MODIFIED FROM BRUNETTI (BRUNETTI 1912)

1. The third longitudinal vein ending exactly at the wing tip 2

   The third longitudinal vein ending just below the wing tip 3

2. Membrane of wing never considerably covered with scales, these being confined to small wing spots. Flagellar joints of antennae without conspicuous 'S' shaped chaetae. Male genitalia with two pairs of appendages.......*Psychoda* Latr.

   Membrane of wing with considerable areas covered with scales. Flagellar joints of antennae with distinct 'S' shaped chaetae. Male genitalia with three pairs of appendages.................. .... *Parabrunettia* Brun.

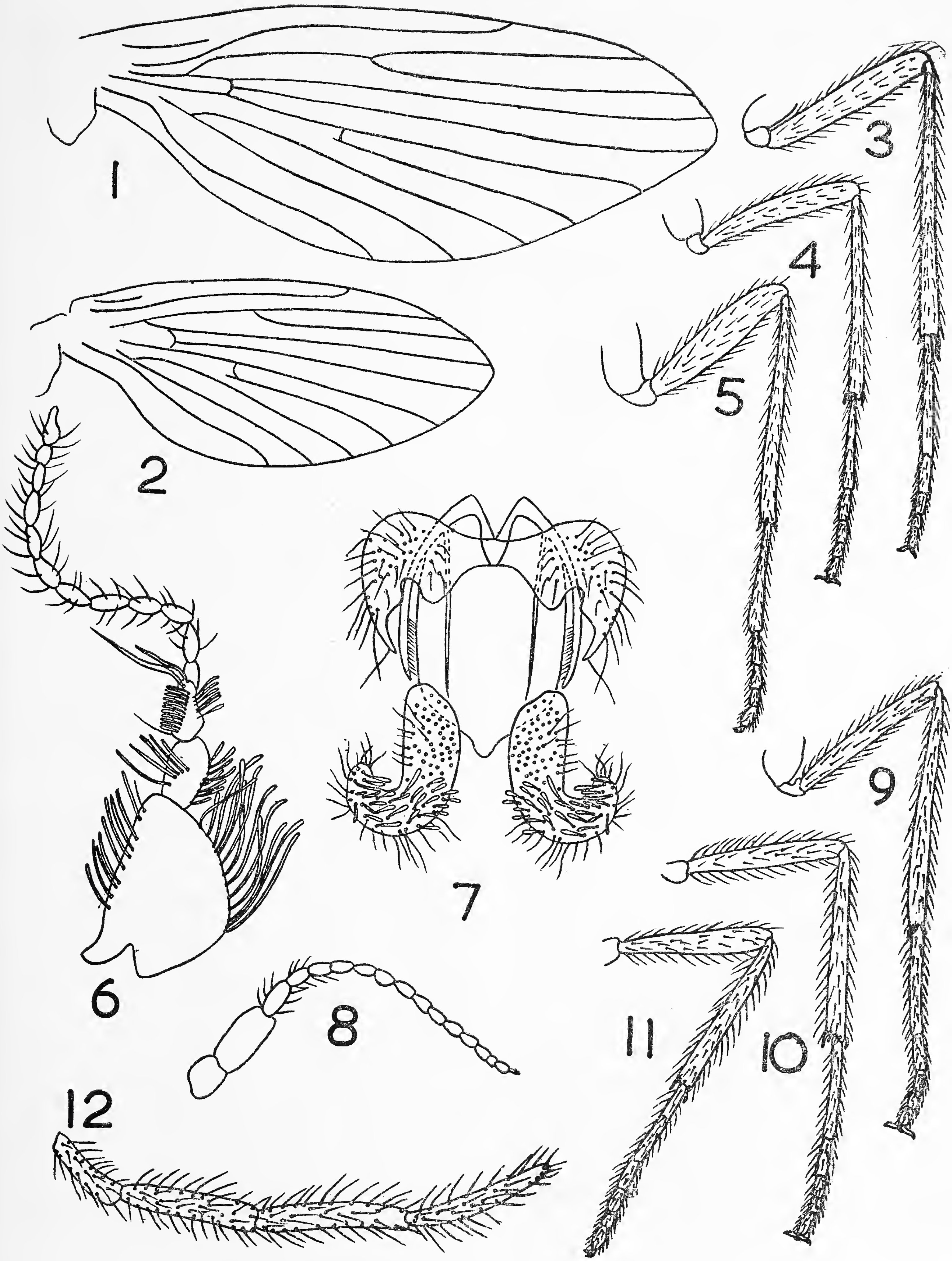
3. Anterior basal angle of wing not abnormally extended, flagellar joints of antennae without or inconspicuous 'S' shaped chaetae. Male genitalia with two pairs of appendages............ .... *Pericoma* Walk.

   'S' shaped chaetae on flagellar joints of antennae present or absent. Male genitalia with three pairs of appendages.......................4

4. Anterior basal angle of wing very disproportionately rounded and distended, so that the auxiliary and first longitudinal veins are very much removed from the costal margin. Membrane of wing wholly covered with scales. Flagellar joints of antennae with conspicuous 'S' shaped chaetae............*Brunettia* Ann.

[1] Accepted April 1983.

[2] Himachal Pradesh Krishi Vishva Vidyalaya, Regional Research Station, Kukumseri, Palampur-176 062, India.



Figs. 1-12. *Beasomia sexdecima* gen. et sp. nov. ♂ ♀ : Length 2.60 mm ♂ : 3 mm ♀.
1. ♀ wing; 2. ♂ wing; 3. ♂ hind leg; 4. ♂ middle leg; 5. ♂ foreleg;
6. ♂ antenna; 7. ♂ genitalia; 8. ♀ antenna; 9. ♀ hindleg; 10. ♀ middle leg;
11. ♀ foreleg; 12. ♂ palpus.

Anterior basal angle of wing normal; 'S' shaped chaetae on the flagellar joints absent, instead first antennal segment clothed with dense lamellae of long setae above, the third segment bears ventrally a pectinal brush of short, conspicuous setae and apically with two elongated, flattened spines, of which one is long and other about half the first in length................ ....*Beasomyia* gen. nov.

Type species: *Beasomia sexdecima* sp. nov.

Beasomia sexdecima sp. nov. (Figs. 1-12)

MALE: Length of body, including genitalia, 2.60 mm; brown, abdomen and legs yellowish-brown, head brown, transverse oval, 1.60 times as wide as long. Antennae (Fig. 6), 2.30 as long as head and nearly equal to palpus, 15 segmented; first segment very stout, cordately oval, nearly 1.30 as long as thick, clothed with dense lamellae of long setae above; the second nearly oval 1.70 as long as thick, 0.40 times the length of the first; the third elongate, cordate, wider basally than apically, 0.90 times the second, bears ventrally a pectinate brush of short conspicuous row of setae, apically with two elongate, flattened, modified spines, of which one is long and other about 0.50 its length; fourth segment oval, 0.60 the third; segments 5 to 13 more or less oval, but gradually becoming shorter and more slender; fourteenth subglobose; terminal segment flask-shaped, with a neck as long as the enlargement. Palpus (Fig. 12), four segmented; first segment short, nearly 3 times as long as thick, second long, uniformly cylindrical, about 1.70 the first, third uniformly cylindrical, distinctly longer than the second, fourth equals the third but more slender. Legs densely setose; fore leg (Fig. 5): femur about 7 as long as thick, tibia 1.25 the femur, tip of tibia dentate and with long subacute spines; tarsus nearly equal to tibia, first tarsal segment nearly 0.50 the tibia and 0.50 the total length of tarsus; second 0.30 the first; third 0.75 the second; fourth 0.6 the third; fifth 1.50 the fourth; claw simple, almost straight, empodium small. Middle leg (Fig. 4): femur similar to fore femur; tibia 1.25 the femur, tip of tibia dentate and with long subacute spines; tarsus nearly equal to tibia, first tarsal segment distinctly more than half the tibia, and nearly 0.60 the total length of tarsus; second 0.30 the first; third nearly 0.60 the second; fourth 0.80 the third, fifth equal to third and 1.25 the fourth; claw simple, almost straight, empodium small. Hind leg (Fig. 3): femur similar to mid femur, tibia 1.40 the femur, tip of tibia dentate and with subacute spines; tarsus 0.80 the tibia; first tarsal segment nearly 0.50 the tibia and nearly 0.60 the total length of tarsus; second 0.30 the first, third nearly 0.60 the second; fourth 0.80 the third; fifth equal to third and 1.25 the fourth; claw simple, almost straight, empodium minute. Wing (Fig. 2): 3.1 mm; 2.20 as long as wide; anterior branch of second longitudinal fork nearly at the middle; fourth longitudinal fork a little before the middle, as in figure. Genitalia (Fig. 7): with three pairs of appendages as in figure.

FEMALE: Length of body including ovipositor 3 mm. Antenna (Fig. 8), 16 segments; first segments 1.40 as long as thick, the second uniformly cylindrical, about 2 as long as thick, the third a little over half the second, the fourth 0.6 the third, fourth to fifteen almost similar, moniliform, sixteenth flask shaped, neck 0.75 the enlargement. Wing (Fig. 1): 3.8 mm; 2.7 as long as wide, rest as in male. Fore leg (Fig. 11): femur cylindrical, 7.5 as long as thick; tibia little longer than femur; tarsus a little longer than tibia, first tarsal segment about 0.50 the tibia, the second 0.36 the first, the third 0.75 the second, the fourth 0.66 the third, fifth 1.40 the fourth. Middle

leg (Fig. 10): femur a little longer than the fore femur, uniformly cylindrical, 8.0 as long as thick; tibia 1.25 femur; tarsus subequal to the tibia; first tarsal segment half the tarsus, the second about 0.40 the first, the third 0.55 the second, the fourth 0.8 the third, the fifth 1.50 the fourth, Hind leg (Fig. 9): femur distinctly longer than the midfemur, tibia 1.40 the femur; tarsus 0.85 the tibia; first tarsal segment 0.40 the tibia, the second 0.33 the first, the third 0.66 the second, the fourth 0.66 the third, the fifth 1.50 the fourth. Claw in all the legs simple and curved. Ovipositor simple, 0.33 the abdomen;

Holotype ♂, *allotype* ♀, dissected on slides. INDIA: *Himachal Pradesh*: Palchan (Kulu Valley), 2900 m, 4.x.1970, B. K. Kaul.

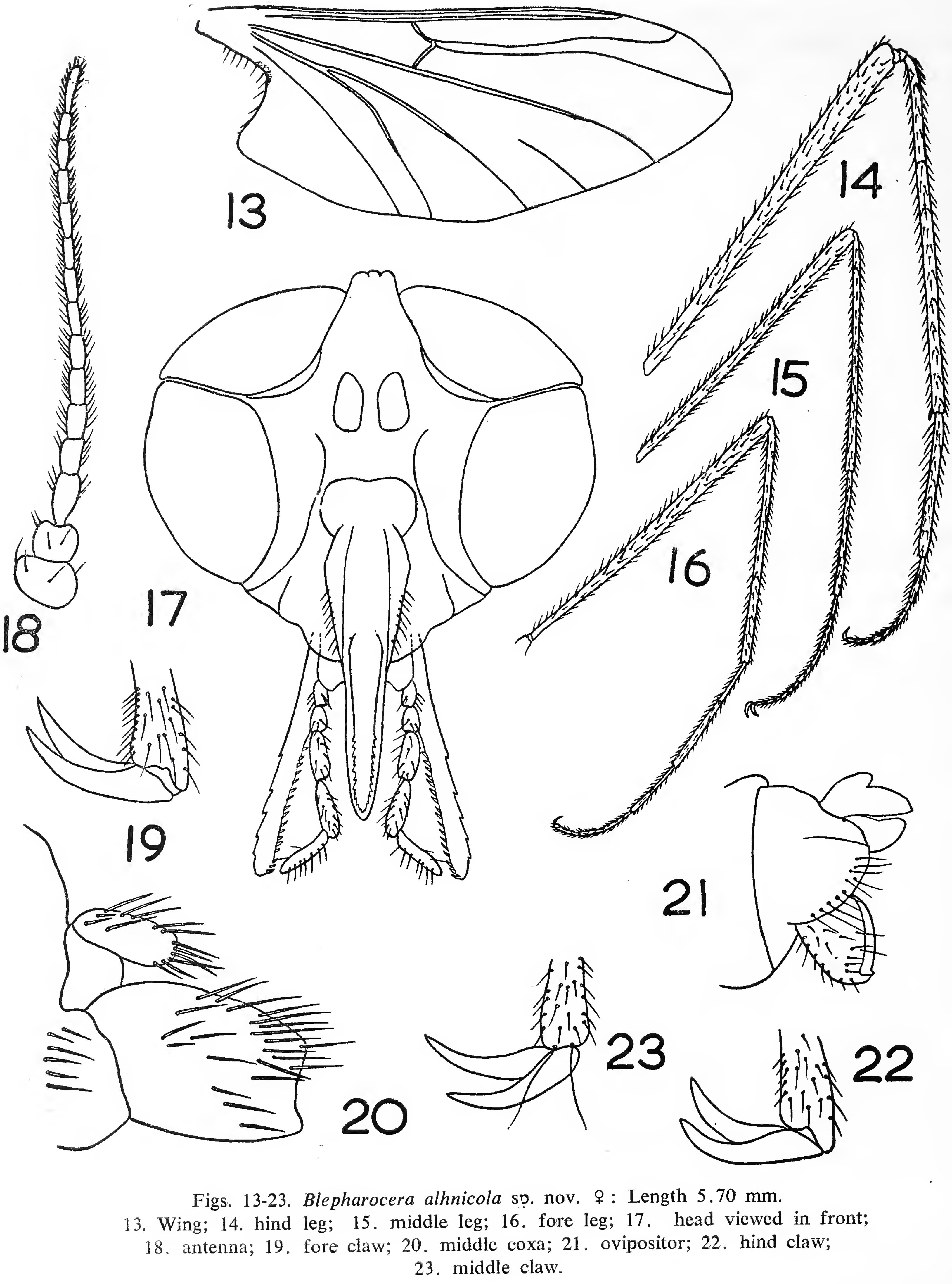
Family: BLEPHAROCERIDAE

Blepharocera alhnicola sp. nov. (Figs. 13-23)

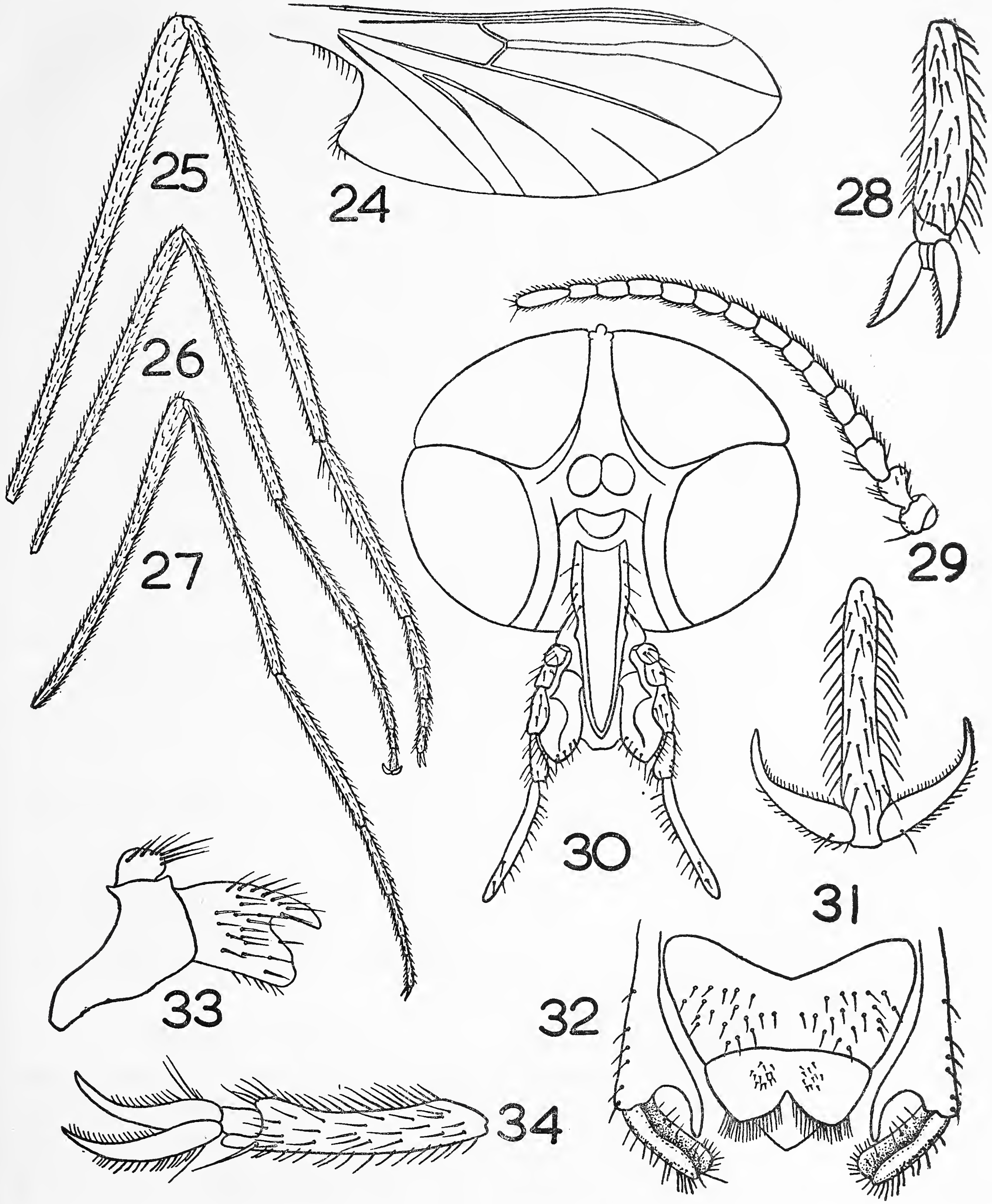
FEMALE: 5.70 mm. Body dark brown dorsally, yellowish brown ventrally, legs predominately brown, venation brown. Head viewed in front (Fig. 17) width nearly 1.15 the height (excluding rostrum) with a bunch of stout bristles between the root of antenna and the border of the ventral eye. Antenna (Fig. 18) filiform, length 1.30 times the head width, 15 segmented, first segment 1.60 as thick as long, second 0.80 the first and 1.20 as thick as long, third 1.40 the second and 2.00 as long as thick, fourth 0.70 the third, fifth 0.80 the fourth, fifth to fourteenth subequal, fifteenth 1.60 the fourteenth. Eyes densely pubescent, contiguous, transversely bisected by a moderately narrow band, dorsal eye orange, width 2.50 times the length and almost equal to the length of the ventral eye; ventral eye black, nearly 1.70 as long as wide, with more and smaller ommatidia than on the dorsal eye. Rostrum 0.83 the height of head, labrum elongate and serrate, mandibles well developed and serrate mesially; hypopharynx serrate at the distal half; palpus (Fig. 17) clothed with spines as in figure, 5 segmented, first and second segment subequal, third 1.60 the second, fourth 1.20 the third, fifth a little longer than the fourth. Wing (Fig. 13) 6.70 mm; 2.60 as long as wide, $R_1+_2+_3$ ending at 0.80 of the wing length, $R_1+_2+_3$-R_4 cross vein almost equal to R_5-M_1 cross-vein, R_4 and R_5 starting at basal 0.43 of the wing length; M_3 incomplete, 0.20 the length of M_1; Cu-An space nearly 0.40 the M_4-Cu space; anal lobe as far as 5.40 times the Cu-An space from An. Halteres nearly equal to the first two abdominal segments, stalk yellow, knob brown. Legs long and slender. Fore leg (Fig. 16): femur long; tibia 0.80 the femur; tarsus a little longer than tibia; first tarsal segment about 0.50 the tibia, second 0.50 the first, third 0.50 the second, fourth a little shorter than the third, fifth subequal to the fourth; claw (Fig. 19) slightly curved. Middle leg (Fig. 15); coxa (Fig. 20) with a spur; femur equal to forefemur; tibia 0.80 the femur; tarsus slightly longer than tibia; first tarsal segment 0.50 the tibia, second about 0.50 the first, third 0.60 the second, fourth 0.60 the third, fifth a little longer than the fourth; claw (Fig. 23) simple and slightly curved. Hind leg (Fig. 14): femur 1.33 the midfemur; tibia 0.90 the femur, tarsus a little shorter than 0.80 the tibia; first tarsal segment about 0.4 the tibia, second 0.33 the first, third 0.6 the second, fourth and fifth subequal, each a little shorter than the third; claw (Fig. 22) simple, slightly curved. Abdomen nearly 0.70 the body, ovipositor (Fig. 21) with a pair of appendages as in figure.

Holotype ♀ on slide, INDIA: *Himachal Pradesh*: Parini (Kulu valley), 2000 m, 15.vi. 1972, B. K. Kaul.

This species can be differentiated from



Figs. 13-23. *Blepharocera alhnicola* sp. nov. ♀ : Length 5.70 mm.
13. Wing; 14. hind leg; 15. middle leg; 16. fore leg; 17. head viewed in front; 18. antenna; 19. fore claw; 20. middle coxa; 21. ovipositor; 22. hind claw; 23. middle claw.



Figs. 24-34. *Blepharocera rahlaea* sp. nov. ♂ : Length 6 mm.
24. wing; 25. hind leg; 26. middle leg; 27. fore leg; 28. hind claw; 29. antenna; 30. head viewed infront; 31. middle claw; 32. genitalia; 33. middle coxal spur; 34. fore claw.

B. autumnalis Kaul (Kaul 1971) by the absence of stout bristles on the frons, different proportions of antennal and palpal segments and in the structure of genitalia. The species also differs from *B. tertia* Kaul (Kaul 1971) in the proportions of the antennal and palpal segments and different structure of genitalia.

Blepharocera rahlaea sp. nov. (Figs. 24-34)

MALE: 6.00 mm. Body blackish-brown, legs dark brown, wings hyaline, veins brown, halteres stalk pale brown, knob dark brown, Head viewed infront (Fig. 30) oval, width 1.33 the height (excluding the mouthparts). Antenna (Fig. 29) 1.25 the head width, filiform, 15 segments, first segment short, length 0.60 the thickness, the second about 1.70 the first and a little longer than thickness, the third subequal to the second but more slender, the fourth 0.70 the third and as long as thick, fifth to seventh subequal, each a little longer than the fourth, eighth to eleven segments subequal, each a little longer than the seventh, the twelfth and the thirteenth subequal to the seventh, the fourteenth subequal to the fourth but more slender, the fifteenth longest, twice the fourteenth. Eyes contiguous, transversely bisected by a narrow band; the dorsal eye orange, width 1.24 the length, the ventral eye black, oval 1.60 as long as wide, with the ommatidia smaller than on dorsal eye. Rostrum about 0.70 the height of head; labrum narrowly elongate, mandibles absent, palpus clothed with small spines, 5 segmented, first segment stout, as long as thick, second 1.80 the first and twice the thickness, third thrice the second, fourth equal to the third, fifth longest 2.70 the fourth. Wing (Fig. 24): 5.80 mm, 2.75 as long as wide, $R_1+_2+_3$ ending at 0.90 the wing length; $R_1+_2+_3$-R_4 cross-vein slightly longer than R_5-M_1 cross-vein; M_3 incomplete 0.22 the length of M_1; Cu-An space 0.40 the M_4-Cu space; anal lobe as far as 6 times the Cu-An space from An. Halteres long reaching the second abdominal segment. Legs long and slender. Fore leg (Fig. 27): femur long and slender, tibia 0.87 the femur, tarsus about 1.20 the tibia, first tarsal segment about 0.50 the tarsus, the second 0.40 the third and subequal to the fifth, claw (Fig. 34) simple evenly slightly curved about 0.75 the fifth tarsal segment. Middle leg (Fig. 26): coxal spur (Fig. 33) present; femur 1.10 the fore femur; tibia about 0.70 the femur; tarsus about 1.30 the tibia, first tarsal segment a little less than 0.50 the tarsus, the second 0.50 the first, the third 0.60 the second, the fourth 0.50 the third and subequal to the fifth; claw (Fig. 31) simple curved and 0.60 the fifth tarsal segment. Hind leg (Fig. 25): longest, femur relatively stout, 1.35 the midfemur; tibia 0.88 the femur; tarsus 0.70 the tibia, first tarsal segment 0.6 the tarsus, the second about 0.3 the first, the third 0.55 the second, the fourth 0.6 the third and subequal to the fifth; claw (Fig. 28) stout, simple, evenly curved, Abdomen 0.7 the body; genitalia (Fig. 32) claspers stout, terminal segments emarginate throughout, clothed with long spines, rest as in figure.

Holotype ♂ on slide, INDIA: *Himachal Pradesh*: Rhala (Kulu valley), 3200 m, 5.vi.1972, B. K. Kaul.

This species comes close to *Blepharocera tertia* Kaul (Kaul 1971) but differs in its larger size, different proportions of antennal and palpal segments, and in the structure of genitalia.

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THREE NEW SPECIES OF GENUS *ISOETES* L. FROM RAJASTHAN, INDIA[1]

C. B. GENA AND T. N. BHARDWAJA[2]

(*With a plate*)

Seven species of the genus *Isoetes* have been recorded from India (Pant & Srivastava 1962, Goswami & Arya 1970). The genus is well represented in Rajasthan (Mital 1969, Gena *et al.* 1976, Mishra & Bhardwaja 1978). Taxonomic comparison of Rajasthan material of this genus with the known Indian material and descriptions of species reported since the publication of Pfeiffer's monograph in 1922 (Svenson 1944, Morton 1945, Taylor *et al.* 1975, Rury 1978) has indicated that at least three of the taxa in Rajasthan could be accorded status of new species. The morphological features of these new species are now being described:

Isoetes rajasthanensis sp. nov. (Figs. 1-4)

Planta terrestris; rhizomorpha typica 2-lobata; folia 7.5-12 cm longa, filis peripheralibus nullis; labium nullum velum tres-quadranti ad totum sporangium tegens. Megasporae trimorphicae, reticulationibus, 330-350 μm, 250-280 μm, 180-210 μm diam.; megasporae articulatae/connatae plerumque; microsporae dimorphicae, laeves, 25-30 μm, 18-22 μm diam.

Plants terrestrial, 7.5 to 12 cm in height (Fig. 1), growing near the margins of streams and on moist soil. Rhizomorph typically 2 lobed (Fig. 2). Leaves 15-39, limb cylindrical, base expanded showing membranous margins, peripheral strands absent. Ligule elliptic with mucilaginous hairs on margins and apex. Labium absent. Velum covering three fourths or almost entire sporangium. Megasporangia elongate (4 x 2 mm) or ovate (3 x 2 mm); sterile cells absent. Megaspores trimorphic, dark brown when wet and white when dry. Megaspores ranging between 330 to 350 μm in diameter. Exine with branched ridges (Fig. 3). Bodily fused megaspores are of common occurrence. Microsporangia rare, elongated (3 x 1.5 mm), microspores dimorphic (Fig. 4), dark brown when wet and creamy white when dry; large microspores 25-30 μm in diameter, small 18-22 μm in diameter, exine smooth.

Fertile: July to September.

Type: Anadera point, Mount Abu, Rajasthan, India, growing on moist ground near the margins of streams. Collector, C. B. Gena (CBG/I-6, Oct., 1976). Deposited at the her-

[1] Accepted December 1982.

[2] Pteridophyte Biology Lab., Department of Botany, Government College, Ajmer 305 001, Rajasthan, India.

barium, Botany Department, Punjabi University, Patiala, India (PUN. 3241).

Isotypes: Herbarium, Pteridophyte Biology Lab., Department of Botany, Government College, Ajmer, India (No. PBL/75/I-9/727), CAL & US.

Paratypes: Mainal (Chittorgarh), Rajasthan, India growing near the margins of a stream during rainy season.

Of the Indian species *I. rajasthanensis* is comparable to *I. sampathkumaranii* Rao in size, absence of peripheral strands and velum characters but differs from the latter in the characters of mega- and microspores. Moreover, *I. rajasthanensis* happens to be the only small sized species with a velum covering three fourths of the sporangium and possessing trimorphic megaspores.

According to Pfeiffer's (1922) scheme *I. rajasthanensis* falls under reticulatae section with affinities to *I. engelmanii* A.Br. but can be distinguished from the latter by its habit (terrestrial Vs. submerged), ligule (elliptic Vs. cordate), velum (almost complete Vs. very narrow), nature of megaspores (polymorphic Vs. dimorphic), megaspore exine (reticulated Vs. honey combed) and microspores (dimorphic Vs. monomorphic).

Isoetes reticulata sp. nov.
(Figs. 5-7)

Planta terrestris; rhizomorpha 2-lobata; folia 4-10 cm longa, filis peripheralibus nullis; labium nullum, velum fere totam sporangium tegens. Megasporae dimorphicae, reticulationbius ramosissimis, 230-245 μm, 170-180 μm diam; megasporae articulatae/connatae omnino nullae.

Plants terrestrial, 4-10 cm in height (Fig. 5) growing on moist soil. Rhizomorph 2 lobed rarely 4 lobed (Fig. 6). Leaves 6-24, limb cylindrical, base expanded, peripheral strands absent. Ligule elliptic with straight mucilagenous hairs on margins and apex. Labium absent. Velum almost covers entire sporangium, except for a basal arched slit. Megasporangia circular (1.5 x 1.5 mm). Sterile cells absent. Megaspores dimorphic; black when wet and white when dry. Megaspores ranging between 230 to 245 μm in diameter, Exine with richly branched reticulations (Fig. 7). Joined or fused megaspores are totally absent. Microsporangia not observed.

Fertile: July to September.

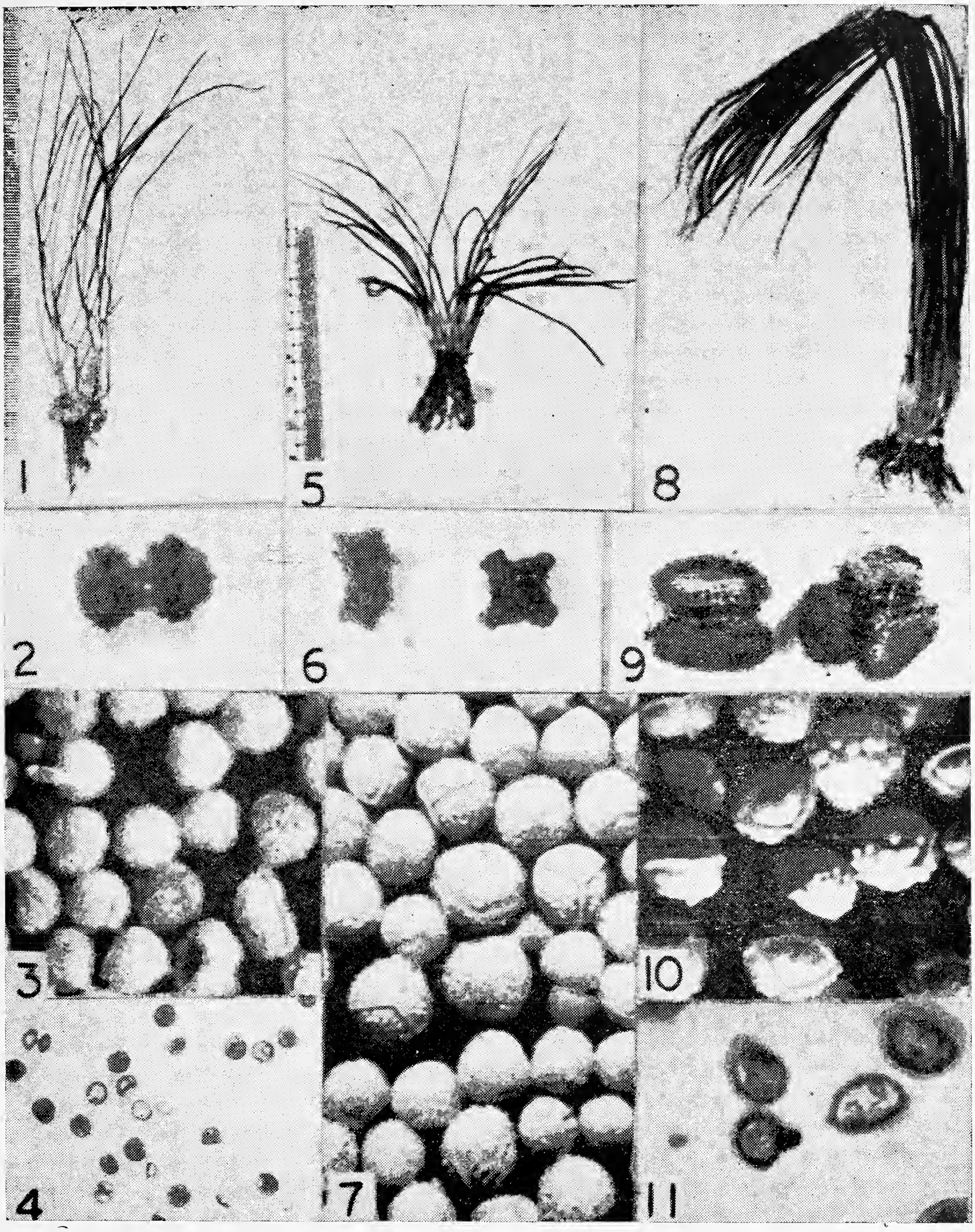
Type: Atru (Kota), Rajasthan, India growing on wet gravelly soil during the monsoon. Collector, C. B. Gena (CBG/I-12, Sept., 1975). Deposited at the herbarium, Botany Department, Punjabi University, Patiala, India (PUN. 3243).

Isotypes: Deposited at Herbarium, Pteridophyte Biology Lab., Department of Botany, Government College, Ajmer, India (PBL/75/I-9/732), CAL & US.

Paratypes: Jhalawar, Rajasthan, India, near the margins of a stream.

This species resembles *I. panchananii* Pant & Sriv. in having dimorphic megaspores with reticulations but differs from the latter in size (upto 10 Vs. 24 cm), velum length (complete Vs. half) and megasporagium shape (circular Vs. oval). Moreover, the sporangial wall of *I. panchananii* is typically brown spotted while that of *I. reticulata* is plain. *I. reticulata* is the only Indian species of this genus with well defined reticulations on megaspores and hence derives its specific name.

I. reticulata falls under the section Reticulatae of Pfeiffer (1922) and may be compared with *I. tuckermanii* A. Br. but differs significantly from the latter in features of habitat (terrestrial Vs. submerged), ligule (elliptic Vs. triangular), velum (complete Vs. one-third), sporangia (circular Vs. oblong) and megaspore



Figs. 1-11. Morphological features of three new Indian species of *Isoetes*.
Figs. 1-4. *I. rajasthanensis* sp. nov. 1. Habit; 2. Bilobed rhizomorph; 3. Megaspores showing branched rides and bodily fused megaspores. x 400; 4. Dimorphic microspores. x 300.
Figs. 5-7. *I. reticulata* sp. nov. 5. Habit; 6. bi-and tetra-lobed rhizomorph; 7. Megaspores showing branched reticulations. x 400.
Figs. 8-11. *I. tuberculata* sp. nov. 8. Habit; 9. bi-and tri-lobed rhizomorph; 10. Megaspores showing round tubercles. x 400; 11. Dimorphic microspores. x 400.

wall ornamentation (branched reticulations Vs. parallel ridges).

Isoetes tuberculata sp. nov.
(Figs. 8-11)

Planta aquatica; rhizomorpha 2-3-lobata; folia 30-45 cm longa, filis peripheralibus; labium veli bene evolutum, velum nullis. Megasporae trimorphicae, 525-550 μm, 460-470 μm, 339-345 μm diam.; tuberculis rotundatis, megasporae articulatae/connatae rarenter; microsporae dimorphicae et laeves, 21-24 μm, 16-18 μm diam.

Plants aquatic; 30-45 cm in height (Fig. 8) growing in ponds and ditches; rhizomorph 2 or 3 lobed (Fig. 9). Leaves 9-33, cylindrical but upper side flattened, base expanded showing membranous unequal margins reaching upwards upto one-third of the leaf length, possessing 4 main and 28 accessory peripheral strands. Many simple or branched tricho-sclereids present in the air cavities; Ligule cordate with curved mucilagenous hairs on margins and apex. Labium well developed with fringed margin and covering lower half of the ligule. Velum absent. Megasporangia circular (5 x 5 mm) or obovate (9 x 7 mm). Sterile cells absent; megaspores trimorphic, ash coloured when wet and white when dry; ranging between 338-550 μm in diameter, exine with large round tubercles (Fig. 10). Joined and fused megaspores rare. Microsporangia obovate (9 x 7 mm) microspores dimorphic, dark brown when wet and light brown when dry; ranging between 16-24 μm in diameter, monolete, exine psilate, smaller microspores with a papillate structure on one side (Fig. 11).

Fertile: July to October.

Type: Atru (Kota), Rajasthan, India, growing in temporary ponds and ditches during the monsoon period. Collector, C. B. Gena (CBG/I-2, Sept., 1973). Deposited at the Herbarium, Botany Department, Punjabi University, Patiala, India (PUN. 3242).

Isotypes: Herbarium, Pteridophyte Biology Lab., Department of Botany, Government College, Ajmer, India (PBL/74/I-9|720), CAL & US.

Paratypes: Salpura, Bhanwargarh (Kota), Dausa (Jaipur) and Ghana (Bharatpur), Rajasthan, India growing in ponds and ditches during rainy season.

Isoetes tuberculata resembles *I. indica* Pant & Sriv. in size, number of leaves and polymorphic nature of megaspores but differs from the latter in the ornamentation of megaspores (round tubercles Vs. pointed tubercles) and triradiate rays (simple Vs. bifurcated).

According to Pfeiffer's (1922) scheme *I. tuberculata* falls under Tuberculatae section and shows affinities with *I. coromandelina* Linn. f. in having round tubercles on megaspores but can be easily distinguished from this species in being smaller in size (30-45 cm Vs. 60-80 cm), ligule (cordate with curved mucilagenous hair on margin Vs. elliptic and devoid of marginal hairs), nature of megaspores (polymorphic Vs. dimorphic), exine ornamentations (tuberculated Vs. Cobwebby) and microspore nature (dimorphic Vs. monomorphic).

An artificial key for the identification of all the Indian species of genus *Isoetes* including the new species is given below:

KEY

A. Adult plants more than 25 cm long, labium well developed, velum absent, peripheral strands and tricho-sclereids present:
  B. Megaspore exine with round tubercles
  C. Megaspores dimorphic
    Exine tubercles closely packed, microspores monomorphic with smooth exine
    ....*I. coromandelina* Linn. f.
  CC. Megaspores trimorphic
    Exine tubercles even sized & rounded microspores dimorphic with smooth exine and

the smaller microspores with a large Papilla on one side.......................
.... *I. tuberculata* sp. nov.

BB. Megaspore exine with pointed tubercles Megaspores trimorphic, triradiate rays branched, microspores trimorphic with tuberculate exine. ....
................*I. pantii* Goswami & Arya

AA. Adult plants less than 25 cm long, labium absent, velum present, peripheral strands and tricho-sclereids absent:

E. Megaspores tuberculated

F. Megaspores monomorphic
Mature megaspores dark brown, velum complete, microspores monomorphic and spiny. .... *I. sahyadrii* Mahabale

FF. Megaspores dimorphic
Mature megaspores ash coloured, velum rudimentary, microspores monomorphic and muricate. .... *I. dixitei* Shende

EE. Megaspores reticulated

G. Megaspores dimorphic

H. Velum partial.

I. Mature megaspores black, exine with branched ridges. ....
........*I. panchananii* Pant & & Sriv.

II. Mature megaspores ash coloured, exine with a net work of ridges.....
...........*I. sampathkumaranii* Rao

HH. Velum complete
Mature megaspores black, exine with branched reticulations. ....
..................*I. reticulata* sp. nov.

GG. Megaspores trimorphic
Velum almost complete, mature megaspores dark brown, exine with branched ridges. ....*I. rajasthanensis* sp. nov.

Acknowledgements

Thanks are due to Prof. N. P. Vadehra, Principal, Government College, Ajmer for providing laboratory facilities. Prof. K. M. Matthew of St. Joseph's College, Tiruchirapalli, India rendered the latin description. Dr. Eric E. Karrfalt of Brooklyn College, New York, U.S.A. was kind enough to forward some material of American species of this genus for comparison. The University Grants Commission, New Delhi, India provided financial assistance for this survey.

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A NEW *SIMPLOCOS* JACQ. (SYMPLOCACEAE) FROM SOUTHERN INDIA[1]

A. N. Henry, R. Gopalan and M. S. Swaminathan[2]

(*With seven text-figures*)

Symplocos nairii sp. nov.

Symplocos cordifolia Thw. affinis, sed foliis parvioribus; floribus parvioribus, solitariis vel in racemos fasciculatis (racemis usque ad 2 cm longis); axe racemi glabro et staminibus 30-35, differt.

Holotypus (*Henry* 68830, CAL) et isotypi (*Henry* 68830, MH-num. acc. 118671-118679) in Muthukuzhivayal in ditione Kanniyakumari in statu Tamilnadensi, India, ad altitudinem *c.* 1400 m, die 27-9-1980 lecti. Paratypi (*Henry* 70370, MH-num. acc. 118680-118691) in Upper Kodayar, versus viam ad Muthukuzhivayal, die 21-3-1981 lecti.

Allied to *S. cordifolia* Thw. but differs in: leaves smaller; flowers smaller, solitary, or clustered in racemes up to 2 cm long; axis of racemes glabrous; and stamens 30-35.

Shrubs or trees up to 8 m tall; branches terete, glabrous, terminal end of young shoots often angled. Leaves up to 12 x 7 cm, alternate, elliptic to oblong or ovate, glabrous, recurved and minutely glandular-dentate along margin, obtuse to acute at apex, cordate or somewhat obliquely cordate at base; midrib grooved above, prominent beneath; nerves 8-12 pairs, faintly prominent beneath; petioles 2-4 mm long, grooved above, swollen at base. Flowers axillary, solitary or clustered in racemes up to 2 cm long; axis of racemes glabrous; bracts and bracteoles up to 11 x 4 mm, persistent, ovate to cordate, appressedly hairy without, glabrous within, acute to acuminate at apex. Calyx tube 1-2 mm long, glabrous; lobes 5, each 2-4 x 1.5-2 mm, imbricate, subequal, ovate, rounded, appressedly hairy without, glabrous within. Corolla lobes 5, white, each 3-4.5 x 1-2 mm, connate at very base, glabrous. Stamens 30-35, in five alternipetalous groups; filaments 2-5 mm long, connate towards the base; anthers globose, bilocular, introrse, dehiscing longitudinally. Disc 5-glandular, glabrous, surrounding the conical sericeous style base. Ovary inferior; style 4 mm long; stigma capitate, punctiform. Drupes 8-20 x 5-6 mm, cylindrical to ellipsoid, smooth, crowned by the persistent calyx-lobes.

Holotype (*Henry* 68830, CAL) and isotypes (*Henry* 68830, MH — acc. nos. 118671-118679) were collected at Muthukuzhivayal in Kanniyakumari Dt., Tamil Nadu, India, at an altitude of about 1400 m on 27-9-1980. Paratypes (*Henry* 70370, HM — acc. nos. 118680-118691) were collected from Upper Kodayar, on the way to Muthukuzhivayal, on 21-3-1981.

In evergreen forests; rather rare.

We are pleased to dedicate this species to Dr. N. C. Nair, Joint Director, Botanical Survey of India, Coimbatore for his significant contributions to Indian Botany.

Acknowledgements

We are thankful to Dr. V. J. Nair, Systematic Botanist for rendering the latin translation and Dr. J. L. Ellis, Systematic Botanist for kindly

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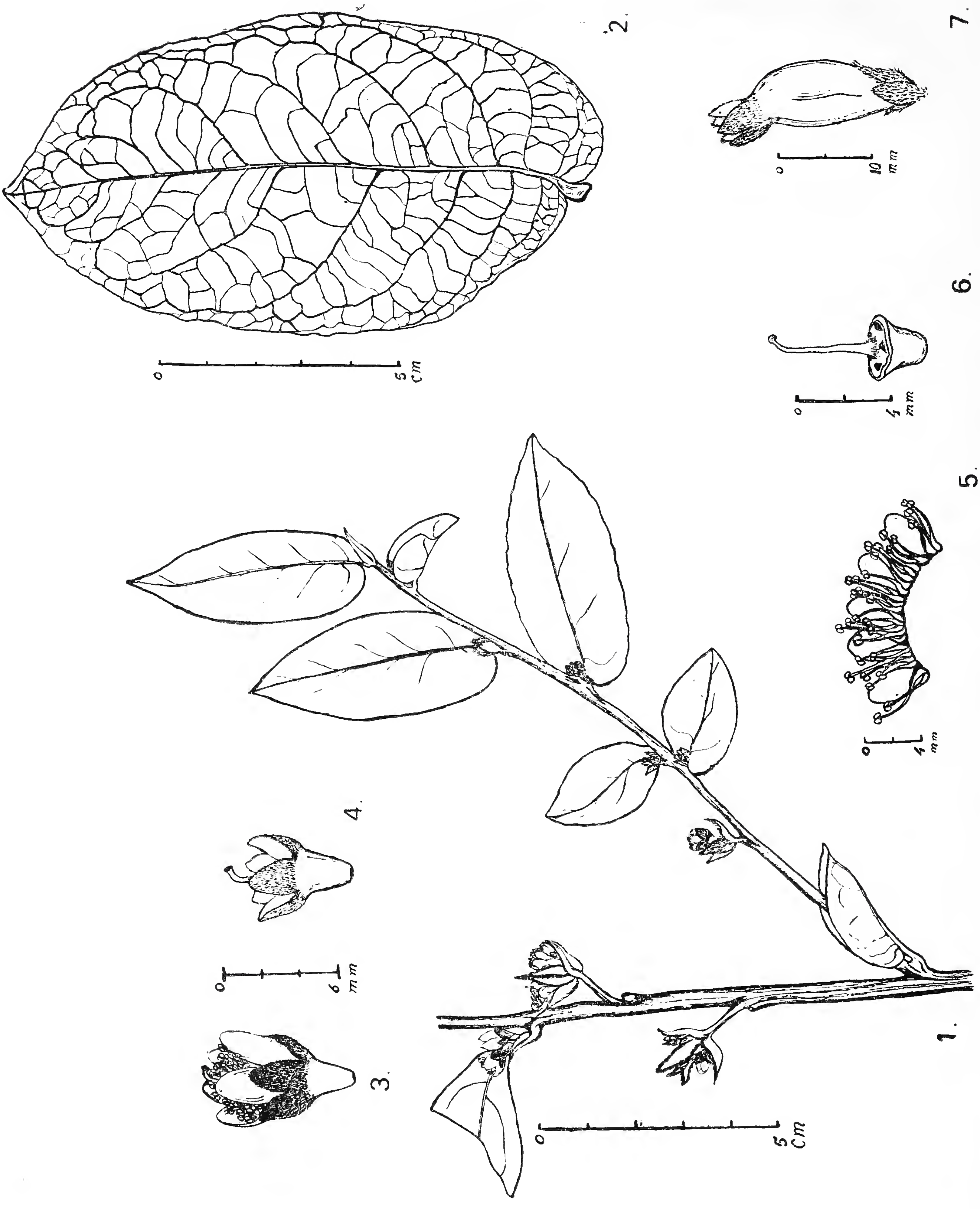
[2] Botanical Survey of India, Coimbatore-641 003.



Figs. 1-7. *Symplocos nairii* sp. nov. 1. Flowering twig; 2. Leaf; 3. Flower; 4. Flower-Corolla and Stamens removed; 5. Corolla split opened; 6. Gynoecium; 7. Drupe.

verifying the sheets of *Symplocos* spp. in CAL. The valuable publications of Dr. H. P. Nooteboom, Rijksherbarium, Leiden, *viz.*, "Revision of Symplocaceae of the Old World (1975)" and Symplocaceae in "A revised handbook to the Flora of Ceylon" (edited by M. D. Dassanayake — 1981) were used to advantage by us for identifying this species.

REVIEWS

1. SUNLIGHT AND SHADOWS. An Indian Wildlife Photographer's Diary. By M. Y. Ghorpade. pp. 158 (30 x 25 cm), with 87 Black-and-White photographs. London, 1983. Victor Gollancz Ltd. Special Indian Price Rs. 175/-.

At the turn of the century Africa saw Cherry Kearton's trail blazing "Land of the Lion" which put wildlife photography on a permanent and sound footing. We did not have to wait long. F. W. Champion burst upon the Indian scene with two books "With a camera in Tigerland" and "Jungle in Sunlight and Shadow" of remarkable quality published half a century ago. They have endured the test of time and can justly be claimed as the beginning of wildlife photography in the sub-continent. The equipment used was primitive: Plate cameras, trip wires and electrically fired flash lamps using flash powders are all echoes from a distant past. Yet the range of his work has remained a standard for all to emulate. After 50 years his photographs appear to be almost contemporary.

The subsequent period however has not produced books of abiding quality on wildlife photography except perhaps for Yella Koffler whose work was left unfinished as a result of an unfortunate and fatal accident which took her away in her prime. We now have Ghorpade's work which bears an unmistakable Championesque title and quality.

The book has 87 black and white photographs and its text is a narrative of the author's experiences primarily in 8 sanctuaries and National Parks of the country. His style is direct, simple and it amply shows his willingness to share his technique and experience with the reader. But its value lies by far in the photographs it contains.

The author has purposely chosen the medium of black and white photography because it gives a greater scope for self-expression and it is indeed a more difficult medium to work with than colour. Yet he has succeeded in producing photographs of 'top' quality, his manifest goal. His basic equipment is medium format Hasselblad camera (unlike most wildlife photographer's 35 mm equipment) which enables him to enlarge his pictures without attendant loss of quality expected with 35 mm negatives.

Unlike some of the photographers of today Ghorpade did not have access to sophisticated equipment such as electronic beams, photoelectric shutters, and custom built cameras. Yet he has succeeded in taking bird pictures of a rare quality. Brahminy mynah (p. 26) and spotted owlet in flight (p. 31, photographed by the author's son) are both works of patience and systematic approach which have paid off. Indian great horned owl with a mouse hanging from its beak and its three young in the background (pp. 28-29) is the best bird picture in the book. It has retained depth and detail rarely found in a flash light picture.

The photograph of Narshimhaswamy Gorge of Sandur (p. 32) has an Ansel Adams like conception except of course, the human figure and it has not quite the grand master's touch.

"Panther approaching the hide" (p. 33) is the only mammal picture in the book taken with a flash and it reminds one of F. W. Champion's photographs though most of the latter's pictures have a frontal view because of the trip wire method.

Elephants are rather strongly represented in the book. "Mother elephants scrubbing babies" (p. 40) is an interesting and uncommon record. By far the best photograph in the book is "Tusker in the rain" (p. 42). The author's description of the circumstances in which this photograph was made is instructive in the sense that some of the finest wildlife pictures are taken in totally unexpected and unplanned situations. Here you have an elephant, a good tusker, obviously enjoying the rain and yet so statuesque in its bearing that it reminds one of a Konarak sculpture. This picture has ably caught a brief, fleeting moment of perfection.

Tiger, as is usual in books on Indian Wildlife, takes the largest share. Out of 87 photographs, 14 go to this cat ! "Tiger on the rock" (p. 71) is a study in serenity. The bush in the background sending out branches at the back of the animal's head gives the picture a regal bearing quite unique. A Tigress and her cub frolicking in the water with their prey (pp. 82-83, 84, 86 photographed by the author's son) is a rare record of animal behaviour.

The big male lion at Gir (pp. 94-95) photographed in the evening light makes a superb picture. The angle of light throws sunlight and shadows on the animal's body and the picture springs to life. Every whisker on the lion's face stands out in slanting light. Its hair of the mane and ears are equally sharp. Quite simply, it is a study in majesty. The big male rhino (p. 112) stands out beautifully against the background of water and vegetation. The picture is crisp, every fold of the animal's skin and wrinkles on its nose stand out. This animal's horn is about the largest I have seen on an Indian rhino.

Our time appears to be that of transition for Indian wildlife photographers. We are slowly opting out of Shikar while wanton destruction of habitat and of animals by poachers still goes on. Our photographers have taken over from where the hunters and shikaris have left off. Consequently, more often than not, they tend to photograph animals which would have been hunted earlier. Ghorpade is no exception, for the animals portrayed in his book fall squarely in this category. The book does not have a single picture for example, of lesser cats or rodents not to mention snakes, butterflies etc. I suppose transition from wildlife photography to Nature photography will take its own time.

The author has selected photographs from a span of over 20 years of photography and yet the number of species represented are indeed few. The section on Bharatpur could surely have had a much larger representation, he has not included a single bird of prey. Deer and Antelope though represented (and there is only one picture of a Gazelle) are not quite what one would have expected. After all they are far easier to photograph than say tigers.

The book consists of the author's experiences in the various sanctuaries and its chapters are so titled. One would have thought that in order to give an ocular account of the jungles and topography some photographs of these should surely have been included. Their absence has made the book singularly unidimensional.

"Sunlight and Shadows" is elegantly produced and as costs go these days it is reasonably priced. Each and every photograph selected for it is indeed of 'top' quality. If anyone has trapped' the range of light' effec-

tively in Indian wildlife photography, it is Ghorpade.

His work will long remain unsurpassed. In fact, with the ever increasing thrust towards colour photography, this book may well be the last of its kind. It is said, "sight is a faculty; seeing, an art". Few are blessed with the capacity to see and Ghorpade is one of them.

DIVYABHANUSINH CHAVDA

2. THE IUCN AMPHIBIA-REPTILIA DATA BOOK — Part 1 Compiled by Brian Groombridge. pp. xliii + 426 (24 x 16 cm), Switzerland, 1982. International Union for Conservation of Nature and Natural Resources (IUCN), Price £ 12.00.

This book is on endangered threatened and inadequately known species of turtles and crocodiles of the world and the Tuatara Lizard of New Zealand area. This is the first volume of a fresh Red Data Book series on Reptiles and Amphibia. The earlier work of Rene Honegger (1979) had become out of date due to extensive data gathered at the Conservation Monitoring Centre of IUCN during the past few years. The book under review is the result of an admirable attempt at evaluation and compilation of data in works published upto early 1982.

Of the 83 taxa dealt with in this book, 12 species (5 Sea turtles, all 3 species of Indian crocodiles, 2 terrapins and 2 tortoises) occur in India. The sea turtles have a very wide distribution. The Gharial and the Marsh crocodiles are limited to India and a few adjacent countries. Of the remaining 4 testudenes the Travancore Tortoise (*Geochelone travancorica*) and Kavalai Forest Turtle (*Heosemys silvatica*) are known only from the hilly forests of south-west corner of India *viz.* Kerala.

Batagur baska, the estuarine turtle is known from Hooghly River, Bangladesh, Burma, Thailand, Malaya and Indonesia. This is said to breed on some islands in Sunderbans, which is possibly its only breeding ground in India.

Geochelone emys is a South east Asiatic tortoise of hill forests perhaps the largest form of this genus in Asia and arguably the most threatened species. The compiler has listed in the first few pages, the 83 taxa he deals with under (i) Systematic Order (ii) Red Data Book survival status category (endangered, vulnerable, rare, inadequately known etc.) and iii) Zoogeographical and country-wise distribution. These lists have obviously been prepared after a very thorough and painstaking compilation and evaluation of all available data and have added to the value of this work. Separate accounts on each of the 83 taxa are given under clear subheadings such as distribution, survival status of populations (this often in the form of a countrywise review), habitat and ecology, threats to survival, conservation measures already taken and proposed, captive breeding etc. which have facilitated a very clear and highly readable presentation. The pride of place in these reviews is given to marine turtles, most of which are on the endangered list and which have attracted considerable world-wide attention during the past few years. The Compiler's 'Remarks' in the concluding part of these reviews are mainly on taxonomic position of the species, mostly non-committal and nowhere definitive, which could have been easily left out from these otherwise excellent reviews.

Mr. Groombridge has undoubtedly achieved much more than preparing an "expanded

treatment of taxa in this volume .... to reach and influence readers outside the conservationist and environmentalist World". His effort has resulted in an admirable source of material for all who may be interested in reptiles in one way or another. It is hoped that this book would induce further worldwide interest in reptiles which remain, inspite of the recent spurt in publications concerning them, much less known than mammals and birds.

P. KANNAN

3. SYMBIOSIS IN THE MANGO-HOPPER: A STUDY IN COMPARATIVE CYTOPATHOLOGY. By Syed Mahdihassan. pp. iv + 40 (21 x 14 cm), with 13 colour plates, Karachi, 1978. Published by the Author. Price US $20.

A result of 'no less than ten years', the booklet on the symbiotes of a cicadellid (jassid) insect, with its beautiful and meticulously drawn coloured figures of the cellular structures, is indeed an outcome of devoted research. The insect, commonly called a mango-hopper, has been studied from a different perspective and the phenomenon of symbiosis has been discussed at length with other homopterous insects. The insect is known to carry two symbiotes, one a thick rod-shaped bacterium and other a micrococcus. Then all sorts of cell-inclusions, and nuclear and protoplasmic debris, exposed with selected stains, have been described and illustrated in detail. Isolation of symbiotes and their metabolic roles; specificity of host-plants of the insect to the symbiosis; cellular structures and the types etc. have been elaborated, to substantiate various interconnected aspects of the subject.

The study also touches upon author's thoughts on some other insects, thus (i) the relationship of the pigment lac-dye with the presence of yeast symbiotes in the lac insect *Kerria lacca;* (ii) production of beta-carotene and the melanin formation in the fulgorid *Oliarus cuspidatus;* (iii) the high cytochrome content of the pink coloured tympannal muscle of the common 'sing cicada'; and (iv) the isolation of a bacterium which is not self-luminescent, but a mutant of which produces luciferin when the firefly offers luciferase, for emitting light to signal the female; etc. are some of the very interesting aspects of the book.

Dr. Mahdihassan, now about 90 years of age, is well known for his more than 100 research papers (albeit many controversial) on different aspects of the lac insects, the first of which appeared in 1919. Inspite of his 'hobby' of research in lac-entomology, however one cannot ignore his professional achievements — that he is a former fellow of the Indian Institute of Science, Bangalore; D. Phil. from Glessen (Germany); Diploma-holder in Agriculture from Oxford; and one who retired as the Head of Biochemistry Division of the Pakistan Council of Scientific and Industrial Research, Karachi.

Symbiosis in the insect pathology has been a major field of specialization for Mahdihassan and in the present book he has been able to discuss his findings vis-a-vis the works of P. Buchner, K. Sulc and H. J. Muller etc. We checked from elsewhere that even as early as 1947, Mahdihassan researched *C. viridis* and its symbiotes (*Curr. Sci.*, *16*: 58-59).

A word about the name and distribution of the subject-insect. Mahdihassan has called it *Cicadella viridis.* However, a search through

the taxonomic catalogues of this group by one of us (RKV) revealed that the valid name of this species is *Tettigella viridis* (Linnaeus, 1758) which belongs to the Family Tettigellidae (Cicadelloidea, Homoptera). A typical jassid of faded yellowish colour and of about 1 cm length, this species is very common in Europe and many other countries like Japan (where Esaki reported it to be injurious to the rice plants). However, it has been rarely reported from the Indian region earlier. Thus, Mahdihassan's discovery of it from all over Pakistan, India and Bangladesh is interesting. The National collections of the Zoological Survey of India, Calcutta, possess specimens from Kyusha Is. (Japan) and Minsk (U.S.S.R.).

Another word about the 13 colour plates (with 3-20 figs. each), which have been explained in the text with meticulous details of description, and which speak of the book as a useful reference to research workers, specially those interested in the study of micro-organisms, biochemistry, stain technology, cell inclusions and their relationship with insect pathology. The lean book covers elaborate descriptions of different kinds of cell inclusions seen in the insect body and the author has presented the work in his own specialized way! The printing of colour plates (the author reports that drawings were made with camera lucida and later painted with water colour), is evidently a costly and technological hurdle. However, it is to the credit of Mahdihassan that he has even earlier published papers (on symbiosis in the membracid *Tricentrus assamensis,* etc.) with coloured plates, in journals like *Archiv fur Protistenkunde* and *Pakistan J. Sci. Indus. Res.* He has discussed therein the importance of coloured plates, comparing it with the black & white plates, though he had to wait for several years to get the former published. The huge cost of printing the coloured plates of this booklet has been borne by the sons and daughter-in-laws (all medicos) of the author, and in lieu he has happily dedicated the monograph to them! Colour plate Nos. 4, 6, 7, 8 have come out very nicely, but plate No. 2 has not synchronized well in our copy.

There are errors of proof-reading here and there, and some references are incomplete, which could have been avoided. However, 'symbionts' have been called 'symbiotes' throughout by the author.

The conclusions drawn by the author in this study may be debatable, yet it goes without saying that it is an interesting book describing various facets of symbiosis and intricacies. The senior scientist of this subcontinent, hence, deserves appreciation for producing this monograph, which should find a place in the scientific libraries and on the study table of students and research workers.

T. S. S. DIKSHITH
AND
R. K. VARSHNEY

4. SUPPLEMENT TO DUTHIE'S FLORA OF THE UPPER GANGETIC PLAIN AND OF THE ADJACENT SIWALIK AND SUB-HIMALAYAN TRACTS. By M. B. Raizada, pp. 355 (21 x 15 cm). Dehra Dun, 1976. M/s. Bishen Singh Mahendra Pal Singh. Price not stated.

Duthie's Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts was originally published in three volumes between the years 1903 & 1920, and

reprinted in two volumes in 1960 by the Botanical Survey of India. The area dealt with in this flora encompasses approximately 1,96,000 sq. miles. It is a heterogeneous area, both topographically and climatically, including such diverse regions as the whole of the Upper Gangetic Plain upto the boundary of Bengal in the east, the Siwalik Hills, the sub-Himalayan tracts from the Jamuna to the Gandat, Malwa Plateau, Eastern Rajputana and a part of Punjab in the neighbourhood of Delhi.

As explained in the introduction, the present author has written a supplement to this flora because countless new genera and species have been collected and described from this area since the completion of the older flora.

The supplement includes a total of 585 species from 105 families. Most of these are new additions whereas a few are nomenclatural changes from Duthie's Flora. Sources of the supplement comprise specimens collected from the area by the author over a period of 40 years, specimens extant in the Herbarium of the Forest Research Institute (DD), the Herbarium of the Northern Circle of the Botanical survey of India, Dehra Dun (BSD), and the Central National Herbarium (CAL); and recent papers published by the Forest Research Institute, Dehra Dun, and the Botanical Survey of India. The supplement covers plants cultivated in gardens and public parks as well as introduced weeds. The family Gramineae is not included.

The names of the families and their sequence have been retained as in Duthie's Flora. However, the delimitation of the families is according to Hutchinson and the spellings of the taxa are according to the International Codes of Botanical Nomenclature (1966 & 1972).

Under the families, genera and species are arranged alphabetically. Each species contains first the nomenclature and synonymy, a brief description, list of exsiccatae, flowering and fruiting times and world distribution. Unlike Duthie's Flora, vernacular names have not been provided in the supplement. In the case of some species, the author has given critical notes on the distribution as well as affinities with other taxa.

Dr. Raizada's supplement contains three new species and 34 new combinations. Further, three new names have been proposed. The nomenclature has been worked out in meticulous detail and in each case, he has explained and justified the nomenclatural change.

A detailed bibliography, an index of Latin names and a short list of corrigenda and addenda complete the work.

The book has some minor drawbacks in the list of specimens examined for each species, the author has not made clear where the specimen is deposited. In many instances, no herbarium has been mentioned. In others, reference is made to Dehra Dun Herbarium and it is left to the reader to decide between DD and BSD. There are also a number of spelling errors, both technical and non-technical. A map of the area covered by the Flora and the supplement would have been a welcome addition.

In conclusion, Dr. Raizada's book is of his usual high standard and it will prove most useful to persons and institutions interested in floristic studies.

A. R. DARUWALLA

MISCELLANEOUS NOTES

1. RECORD OF THE FULVOUS FRUIT BAT, *ROUSETTUS LESCHENAULTI* (DESMAREST, 1820) FROM SIKKIM, WITH NOTES ON ITS INTERESTING FEEDING HABIT AND STATUS

In Indian limits, the Fulvous Fruit Bat, *Rousettus leschenaulti* (Desmarest, 1820), is known from the Himalayan foothills of north-eastern India and Uttar Pradesh to the southern Peninsula (Blanford 1891, Ellerman and Morrison-Scott 1951, Brosset 1962, Khajuria and Ghose 1970, Khajuria 1979, Rookmaaker and Bergmans 1981). According to Prater (1965, p. 179), though this habitual cave-dwelling species of the tropical region is found as high as 2150 m. in the temperate zone of the Himalayas, the extant literature does not record its occurrence in Sikkim. However, during a recent field survey in the northern part of that State, two specimens of the Fulvous Fruit Bat were collected in a mist-net, and they constitute the first authentic record of its occurrence in Sikkim.

The specimens were collected at Teen-ku-Pokhari which is a hill stream pool in the Hee Gyathang reserve forest on the western slope of the Tista Valley, about 17 km. WSW of Mangan, the District Headquarters of North Sikkim. The lower parts of the valley here has extensive cultivation. The higher slope, holding the reserve forest, sustains luxuriant middle hill montane forest.

The weather as recorded in the field on collection date are: Temperature: Max. 19°C; Min. 11°C. Relative Humidity (%): Max. 80; Min. 47.

Data on their size together with their interesting feeding habit and status, are given below:

Material: 1♂, 1♀ (subad.): Teen-ku-Pokhari, *c.* 1829 m, Hee Gyathang, North Sikkim; 9 January 1982; R. K. Ghose coll.

Measurements: External: 1♂: Forearm: 84.7. Skull: Occipitopremaxillary length: 37.6; postmolar length: 23.2; cranial width: 15.5, zygomatic width: 24.1; bulla: 4.5; m^2-m^2: 12; C^1-C^1: 8.3; M_3: 1.6 x 1; C^1-M^2: 14.5.

These bats, in hundreds, were noticed to fly and dive repeatedly over the water surface of the hill stream pool, which was full of small fish and tadpole, during evening and night. With night scope and spot light they were observed to be scooping up something from the water. It was believed that they were catching fish. This is corroborated by the gut content of the male specimen netted which showed the presence of undigested bone pieces and muscle fibres of fish, and some muscle fibres of fish were collected from the teeth of the female. This is in sharp contrast to its usual fruit-eating habit.

The three kinds of small hill stream fishes collected from the place were identified as *Garra gotyla* (Gray), *Danio aequipinnatus* (McClelland), *Schizopyge progastus* (McClelland), all belonging to the family Cyprinidae. The anuran tadpoles could not be properly identified.

Some tropical species of bats that visit the temperate zone of the Himalayas in spring and summer, migrate to warmer areas in winter. The few that have adapted themselves to the cold climate and do not migrate, either

hibernate or show a temporary period of inactivity due to the severity of low temperature. It is interesting to note that the population of the Fulvous Fruit Bat under report did not migrate, nor did it show any discomfort due to the low temperature. Moreover, it has adapted itself to eating-fish, most probably due to the scarcity of fruits in the surrounding forests during the severe cold weather in January. This bat should normally have migrated to a place where fruit which is its usual diet, is available, but it is of interest to note that instead it has developed a new food-habit. Blanford (1891), reported *Rousettus amplexicaudatus* (E. Geoffroy, 1810) feeding on exposed molluscs at Moulmein, Burma.

Blanford (op. cit.) regarded *Rousettus amplexicaudatus* and *Rousettus leschenaulti* conspecific. Ellerman and Morrison-Scott (1951), however, treated them as separate species. In a recent work Rookmaaker and Bergmans (1981) pointed out that the Burmese species of the fruit bats referred to in literature as *Rousettus amplexicaudatus* are actually *Rousettus leschenaulti.* They (Rookmaaker and Bergman, op. cit.) also mentioned some morphometric variations in some specimens of *Rousettus leschenaulti,* which overlap those of *Rousettus amplexicaudatus.* The measurements of M_3 in our male specimen is also within the range of that of *R. amplexicaudatus* (1.1-1.7 *vs.* 1.7-2.1) in *R. leschenaulti* as mentioned by Rookmaaker and Bergmans (op cit.). It would, therefore, appear that a detailed study on the taxonomic characters of the Fulvous Fruit Bats might be of interest.

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2. A FEEDING ASSOCIATION BETWEEN A HETEROPTERAN BUG AND LANGURS

Animals have often been observed to scavenge food wasted by primates (e.g. Elder & Elder 1970, Glander 1979, Newton in prep.), but all such associations appear to be opportunistic and facultative. Observations from central India, presented here, suggest an obligate commensalism in which bug nymphs feed solely on fruit dropped by monkeys from one tree species.

Scattered through the sal (*Shorea robusta*) or moist deciduous forest surrounding the central meadows of Kanha Tiger Reserve (Mandla District, Madhya Pradesh) are isolated boulder-strewn hillocks vegetated with mixed (dry deciduous) forest. On one of these hillocks (locally called "chattans") 1 km. east of Kanha Forest Village (at 22° 17′ 15″ N, 80° 30′03″ E) "kosum" trees (*Schleichera oleosa*, Sapindaceae) fruited in May, June and July, straddling the end of the hot season and early monsoon. Their green ovoid fruits are 2.5-3.0 cm in diameter and, within a hard coat, contain a pulpy, acidic, mucilaginous arillus surrounding oily cotyledons (Brandis 1874). Common langurs, *Presbytis entellus*, Colobinae, when feeding on these fruits, rejected and dropped to the ground the coat with some of the arillus coating the inside surface. Frequent feeding by langurs resulted in a considerable quantity of fruit debris accumulating below the canopy.

During May, June and July of 1980, 1981 and 1982 I noted that beneath all fruiting kosum trees on the chattan, there were large populations of the bug *Leptocoris augur* (Fabricius 1781) (Hemiptera, Rhopalidae). None were observed from August to April inclusive in any year. During the hot season (May to mid-June) the bugs, mainly nymphs, were found exclusively below the kosums with none more than 1 metre from the canopy's vertical projection to the ground. Nor were the bugs found more than 1 metre up the tree bole. On 18 June 1981, 510 nymphs and adults of *L. augur* were counted below the canopy of a single tree (approximately 50 m^2 cross-sectional area). The majority of the bugs were aggregated at the fruits with their probosci extended into the exposed mucilaginous arillus. Bugs congregated at intact fruits but did not feed, being unable to reach the mucus through the hard coat. When I broke open a monkey felled fruit, in the manner of a langur and placed it below the canopy, twenty bugs converged on the fruit within two minutes.

Although most tree species in the area fruited in the hot season, the bugs only occurred below kosums and was the only species noted scavenging the fruits. The bugs, which also occurred below fruiting kosums on adjacent chattans, were rarely seen to utilize other food sources such as the leaves of bamboo, saplings and herbs. Since opened fruits are dropped only by langurs the bug is dependent on the primate for processing an otherwise inaccessible food source. These observations suggest that during the hot weather the bug is monophagous and host specific.

However with the arrival of the monsoon (23 June in 1981) the behaviour of *L. augur* changed dramatically. The bugs, now mostly matured into imagos, dispersed from the kosums and were found scattered over the chattan feeding on grasses, herbs and saplings. They were not found in the tree canopies or the surrounding sal forest and were no longer aggregated below kosums. The sudden dispersal of bugs coincided with the arrival of the

monsoon and not with the browning of the fruits, which mostly occurred in late June. Langurs continued to feed on the drying brown fruits and a few bugs remained below the kosums scavenging the reduced quantity of arillus present on the fruit debris.

These observations suggest a commensalism in which during the hot season *L. augur*, mostly as nymphs, may be obligatorily dependent on langurs for their food. With the arrival of the monsoon, the vegetation flushes, the climate ameliorates and the bugs are 'released' from the association, dispersing from the kosums. Concurrently they switch from being frugivorous specialists to phytophagous generalists. An additional advantage in living beneath kosum trees is that the microclimate is relatively benign owing to the leafed canopy. Most other sympatric tree species are leafless during this season and therefore, below their skeletal canopies, associating bugs would be subjected to high heat stress and water loss (temperatures to 44°C in shade).

I suggest that the bug's dependence on a shady tree and a prodigal primate evolved to facilitate its survival and growth during the invertebrate depauperate, hot, dry summer. The selective advantage of this shift in life history, from the usual pattern of nymphal development in the monsoon, may be that the nymphs avoid the competition, predation, parasitism and fungal attack which are at their worst in the monsoon. However, if *L. augur*, is an obligate commensal, it is dependent on the vagaries of langur ranging and feeding, for the survival and growth of its nymphs.

ACKNOWLEDGEMENTS

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3. WHITE DOTS ON THE LEGS OF BARKING DEER

I had kept an orphaned muntjac for over one year in my house (Wildlife Warden's Bungalow) at Shencottah, before the animal was taken to the Wildlife orphanage at Mundanthurai. The animal was brought to me when it was about 15-25 days old.

It had conspicuous white dots on its legs just above the hoofs. This aspect of coloration has not been mentioned in Prater's BOOK OF INDIAN ANIMALS and on the animal in the colour plate (Plate 68).

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4. A NOTE ON CANNIBALISM IN DESERT RODENTS

Cannibalistic propensities have been noted in various small mammals by several workers (Prakash 1964, Gupta and Agarwal 1968, Ghosh 1970, Purohit and Bohra 1973). Most of the instances reported on cannibalism, however, pertain to laboratory maintained rodents. The shortage of food has been regarded to be the main cannibalism inducing factor in rodents. I have handled breeding and rearing of *Tatera indica, Meriones hurrianae, Rattus meltada, Rattus cutchicus, Rattus rattus, Golunda ellioti* in laboratory. Irrespective of any shortage of food and water (provided *ad libitum*) these rodent species exhibited partial to full cannibalistic activity on new born young. Some times only mother and just born litters were left undisturbed in large breeding cages with ample greens as well as dry food and water, even then, complete devouring of litters occurred. These observations probably rule-out the possibility that only the paucity of food induces cannibalism. Further, cannibalism may not be regarded as an inborn habit because in several instances, more than one rodent caught in the same live trap, have not revealed this phenomenon. Therefore, devouring of litters by the mother under optimum living conditions can be explained in the man-made and artificial environment of the laboratory is considered a stress reaction — the stress of captivity. In the natural habitat of rodents such stressful conditions probably do not occur and hence such devouring of litters may not happen. This fact is confirmed by observations made on the burrowing patterns of field rodents where no such damaged young are encountered.

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5. BANDICOOT RAT SEIZING A SNAKE

At dusk on March 15, 1982 when a fresh-water snake, *Enhydris enhydris* Schneider, was moving at the water's edge of a roadside ditch at Kakdwip, 24-Parganas, West Bengal, a large Bandicoot rat, *Bandicota indica* (Bechstein) suddenly came out of a nearby bush and caught the snake. I focussed a 3-celled torch on the spot and saw that the Bandicoot was moving in to the bush holding the snake at about its anterior quarter of the body. I went close to the site but could neither locate the rat nor the snake.

It is believed that the rat might have seized the snake as food. Like all other rats the Bandicoot rats are omnivorous and feed on household refuse, on grain and vegetables, and occasionally attack poultry (Prater 1965). Chakraborty and Chakraborty (1982) reported from the analysis of the gut contents that *B. indica* accepts a wide spectrum of animals, right from insects to amphibians. Behura (1958), however, reported a musk shrew attacking a snake.

Rats are, as a rule, known to be seized and swallowed by snakes. Perhaps this is the first occasion I have known of a Bandicoot rat seizing a snake.

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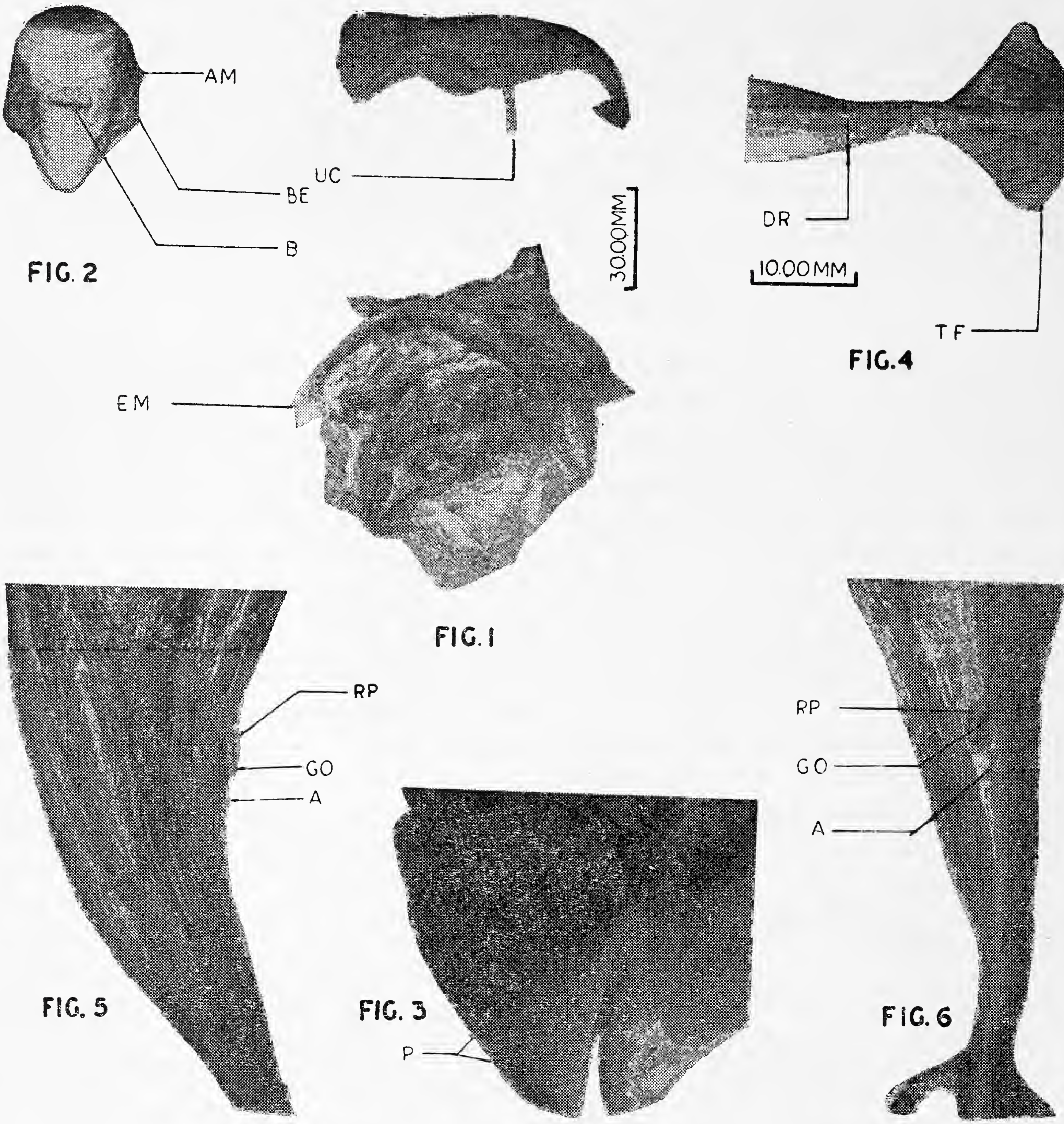
6. RECORD OF A FOETUS OF THE FINLESS BLACK PORPOISE FROM GOA COAST

(*With six text-figures*)

On the morning of February 20, 1980, when collecting samples of fish on the beach of Vasco-da-Gama (Goa), I saw some fishermen butchering a shark-like, smooth-bodied, black



Foetus of *Neophocaena phocaenoides*

Fig. 1. Entire foetus, lateral view; Fig. 2. Head, frontal view; Fig. 3. Head, lateral view (enlarged); Fig. 4. Tail with tail-fluke; Fig. 5. Inguinal region of belly, genital orifice covered by rod-like papilla; Fig. 6. Inguinal region of belly (rod-like papilla of genital orifice pushed aside).

Abbreviations: A— Anus; B — Blowhole; BAM — Bulging of Auditory Meatus; BE — Bulging of Eye; DR — Dorsal Ridge; EM — Extra-embryonic Membrane; GO — Genital Orifice; P — Papilla; RP — Rod-like Papilla; TF — Tail-fluke; UC — Umbilical Cord.

animal. It had no dorsal fin, and the tail flukes were horizontal. There was a pair of wing-like flippers at the position of pectoral fins, and the head was abruptly round. The pieces of flesh the fishermen were making had a thick layer of blubber beneath the skin. The viscera had the uterus containing a foetus. The gut was examined and a rare trematode was recovered which is being reported separately.

The foetus with the umbilical cord was enveloped in a transparent sac richly supplied with blood vessels and was clearly seen through it. Later, it was identified as **Neophocaena phocaenoides* (Cuvier) in the light of the observations made in the field as well as the foetus which has developed the main external features of the adult. The identification was confirmed by the Mammals Section, Z.S.I., Calcutta.

The Finless Black Porpoise or the Little Indian Porpoise, *Neophocaena phocaenoides* (Cuvier), occurs in the coastal waters of India. Pillay (1926) and Dawson (1959) recorded its occurrence off Trivandrum and Malpe respectively. Balan (1976) reported a female juvenile of this cetacean from Calicut. Dawson (1959) also reported four embryos of this animal. The present female foetus, whose account is given below, was recovered from its mother caught near the mouth of Zoari river off Vasco-da-Gama (Goa).

The creamy white foetus was completely enveloped in the extra-embryonic membrane profusely supplied with blood vessels when it was recovered from the uterus. The head is abruptly round and is roughly triangular in outline. The crescentic blowhole (nostril) is median and central in position. The head is at right angles to the horizontal axis of the body. The snout is a bit drawn and appears beak-like. The eyes are beady and completely closed, and are situated at a distance behind the angle of the mouth. Behind the eye is the bulging of the auditory meatus but an external aperture is absent. There are four papillae on either side of the upper lip arranged in a line parallel to that of the mouth opening. The three anterior ones are close to each other while the fourth one is slightly distant. The head is marked off from the body by a slight narrowing of the intervening space suggestive of a neck. Near the beginning of the body there is a pair of pectoral flippers. The triangular dorsal fin is characteristically absent. Instead, the back of the body has a long depression in which minute scales are embedded in the skin. This is a characteristic feature of the foetus of the Finless Black porpoise. The tail tapers behind the dorsal depression and is streamlined. The tail flukes are horizontal and there is a notch in the middle. The tail flukes are stretched outwards and the posterior edges are semi-circular. The middle line of the tail is slightly ridged dorsally and ventrally. The ventral ridge extends up to the anus while the dorsal ridge extends up to the depression. The genital orifice is covered by a muscular rod-like flap inserted at the anterior corner of the orifice. The anus is situated behind the genital orifice. On either side of the reproductive opening there appears a very faint trace of a slit which is the seat for mammae.

The important body measurements are given below:

Length of body from anterior extremity of head to notch of tail fluke	100 mm
Width of body at the position of umbilical cord	24 mm
Length of head	28 mm
Width of head at level of eyes	19 mm

* *Neomeris* Gray, 1846 is junior homonym being preoccupied by *Neomeris* Lamouraux, 1816. Palmer (1899) rechristened it as *Neophocaena*. Also see Hershkovitz in *Smithsonian Inst. Bull.*: 246.

Blowhole across	5.5 mm
Mouth opening	7.5 mm
Angle of mouth to centre of eye	5 mm
Width of the base of insertion of flippers	6 mm
Length of flippers from centre of base of flippers	15 mm
Length of tail from anus to notch of tail fluke	38 mm
Distance from the anterior margin of the genital orifice to the attachment of the umbilical cord	14 mm
Tail fluke across	16.5 mm
Length of tail fluke from beginning to notch	11 mm
Length of umbilical cord	50 mm

Like the present foetus, Dawson's (1959) specimens measuring 93 mm and 98 mm have more or less beakless snout, and the mouth opening is almost vertical, but in the 155 mm long foetus the snout assumed roundish appearance and opening of the mouth became slanted. In Balan's (1976) female juvenile specimen measuring 669 mm long, the snout is completely round and the mouth opening is horizontal as in the adult animal. The colour of the dorsal surface is black while that of the ventral surface is pale. Thus, as the developing foetus grows in age, the colour of the body changes from creamy white to deep greyish black, and the somewhat beak-like appearance of the snout changes to beakless condition as in the adult.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, Calcutta for providing facilities, and to the Deputy Director-in-Charge, Desert Regional Station, Jodhpur for taking kind interest in the study. The author is also thankful to Dr. V. C. Agarawal, Superintending Zoologist, Z.S.I., Calcutta for help in the identification of the foetus. Thanks are also due to Mr. S. A. Basit, photographer, for preparing the photographs.

M. HAFEEZULLAH

DESERT REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JODHPUR-342 006,
February 16, 1982.

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7. CATTLE EGRETS (*BUBULCUS IBIS*) FEEDING ON CICADAS ON TREES

On a recent trip to the Borivli National Park (18th April 1982) with Mr. Humayun Abdulali, we stopped to watch a number of cattle egrets (*Bubulcus ibis*) scattered over a large tree (*Garuga pinnata*) which was in fruit and which had many cicadas calling therefrom. As we watched, the egrets were seen to stalk along a branch and when near enough, jab at the cicada after swaying the head two or three times from side to side presenting (as Drs. Salim Ali & Ripley have said in the HANDBOOK 1 p. 67) a comical appearance.

Egrets have been known to feed on bluebottle flies from nectar-yielding flowers of

Salmalia and *Erythrina* and even from toddy pots hung up on date palms, but we do not recall having read of their stalking cicadas along the branches of trees.

The cicadas were extremely numerous calling from many trees and we later saw more egrets in small parties of 3 to 5 perched on trees in different places apparently for the same purpose. Though they were unable to catch the insects settled on the under surface of the branches on which the egrets were perched, this appears to be another instance of the adaptability of this bird which has no doubt helped it to retain its numbers around Bombay, and also to establish itself in different parts of the world.

MADHURIMA SOCIETY,
M. G. ROAD, KANDIVLI (WEST),
BOMBAY-400 067.

S. G. MONGA

C/20 KASTUR MAHAL,
SION, BOMBAY-400 022,
August 21, 1982.

PARVISH PANDYA

8. UNUSUAL PLUMAGE IN A CATTLE EGRET *BUBULCUS IBIS COROMANDUS* (BODDAERT)

On 6th June 1982, while visiting the Borivli National Park with Mr. Humayun Abdulali, we stopped to watch a large number of Cattle Egrets *B. ibis coromandus* (Boddaert) feeding in a semi-flooded grass field by the road. We counted 17 in all-white and 22 in breeding plumage. The latter group included a strikingly coloured bird which had the usual yellowish orange plumes on its head and breast, pale pink legs with the rest of the body a delicate rosy pink, and with absolutely no trace of white anywhere.

A reference to Thomson's DICTIONARY OF BIRDS (1964, page 643) reveals a note to the effect that the plumage of some birds does not depend upon any structural character but on the infiltration of the feathers with chemical substances derived from the natural food of the species, the absence of which in captivity may lead to loss of colour. There is pink suffusion in the plumages of some birds like Flamingos (Phoenicopteridae) and Goosanders (*Mergus merganser*) that live on small aquatic animals.

This phenomena does not appear to have been observed in the Cattle Egret (*B. ibis coromandus*) and it would be interesting to see how long the colour remains and whether it appears in other individuals also. I understand from Mr. Abdulali that he recently noted several species of flamingos at Slimbridge, U.K. which had quantities of "Carotin" included in the food offered to them. Each species acquired the red or pink in that part of the plumage peculiar to itself, the distribution being presumably genetically controlled.

27A/1, CIVIL LINES,
NAGPUR,
June 16, 1982.

NITIN JAMDAR

9. SOME NOTES ON THE INDIAN REEF HERON

The Indian Reef Heron is found throughout the maritime habitat of Gujarat. In Kathiawar peninsula I have observed it in its central portion and along the Kutch coast. It is, however, not restricted to the coast. The breeding season is a prolonged one commencing from February and ending about August depending upon local conditions. The peak season appears to be from March to May.

The two most prominent phases of this heron are, the white and slaty-grey forms which vary from sooty to grey. Both sexes are seen in these phases. I have seen pairing of white with white and slaty with slaty as the more common combinations. Nevertheless, I have seen white × slaty and vice versa and with grey forms. In the Gulf of Cambay the slaty forms are seen more. What is surprising is that although both parents may be slaty, their young may be white or mixed and the same with white parents, or both young may be slaty or slaty and white in the same nest. Some of the slaty and grey forms have white patches on one or both wings in adults and young alike. All these varied phases may sometimes be seen in one Heronry, the genetics of which require scientific study. The young of white forms often have black or grey featherings but slaty young do not invariably have this pattern. The fledglings of the dark slaty form are usually light grey colour with whitish underparts. I have seen groups of white forms frequently in the Gulf of Kutch and North-west Kathiawar than in South-east Kathiawar.

The composition of a breeding colony is that the species prefers to nest together and may monopolise an entire tree, yet, I have seen them nesting with other herons, storks, white ibises and cormorants. The trees selected depend upon the suitability of the site and I have even seen them nesting in Neem trees. Trees in which large Fruit Bats roost are used by all the above mentioned birds but not cormorant.

The white form of the Reef Heron is easily distinguished from the Little Egret by its stouter bill, colour of lowest mandible and also posture.

The nesting in trees or groups of trees by this heron in urban areas is preferred probably because of suitability of type of trees and closeness to their feeding grounds. Nevertheless, I have seen them nesting away from urban areas throughout the coast where there were mangrove forests, now denuded or heavily cut in many places and to provide browse for camels and fuel-wood. There is no doubt that in such sites the breeding is later, from May onwards.

In the littoral, especially in the Gulf, I find sea-food abundant for shore birds and reef herons take full advantage of the situation specially during spring tides when tides in the gulf have high incidence of rise and fall. A very interesting observation during the breeding season in the gulf especially in the muddy and murky silted waters and in estuaries is the feeding behaviour. Most of the food gathered is during the ebbing, ebb and flow of tides and not during full flood at which time there is a marked lull in feeding of young in the heronry. At full tide, the mud flats and sands are covered by water and feeding habitat though it may appear extensive, food itself is submerged and in murky water in which it is less visible and more difficult to obtain. In monsoon, these herons visit jheels and tanks and streams although much of their food is taken in gulf, bays,

creeks and estuaries and consists of Mud-Skipper, Fish, Prawn, Crab, Eel and other marine and aquatic animal life, and in the vicinity of fishermen. Although, feeding of nestlings takes place at day and night, much depends upon tidal timings. The heronry as mentioned by other writers is fairly silent. Crows are a scourge to nesting birds and yet the parents alternately guard their eggs and nestlings carefully. Predation by raptors is negligible but young that fall to ground are often killed by pariah dogs, cats and jackals.

K. S. DHARMAKUMARSINHJI

26 LOTUS COURT,
JAMSHEDJI TATA ROAD,
BOMBAY-400 020,
May 6, 1982.

10. EXCEPTIONALLY LARGE EGGS OF THE COMMON HOUSE CROW, *CORVUS S. SPLENDENS* VIELL.

On 15th April 1982, I saw a pair of house crows (*Corvus s. splendens*) complete their nest in a copperpod tree in my garden at Kandivli, Salsette, in North Bombay.

For the next two days there appeared to be no activity around the nest but on the 18th April it contained one egg. This appeared extraordinarily large that I took it. Again for two days there was no activity and I thought that the nest was deserted. But on the 21st April morning there was another large egg which I took, to be followed by a third egg on the 22nd April.

The three eggs measured and weighed as follows :-

1. 47.55 x 25 mm......................17 gm
2. 44.2 x 26.75 mm....................15.5 gm
3. 43.55 x 25 mm......................14.2 gm

Stuart Baker (1932) in NIDIFICATION OF BIRDS OF THE INDIAN EMPIRE (Vol. I, pp. 18) gives the average size of 200 eggs as 37.2 x 27 mm (maxima 44.1 x 27.4 mm and 41.1 x 29.1 mm; minima is 30.4 x 25.4 mm and 32.0 x 23.0 mm).

The eggs obtained by me thus are appreciably larger than those noted earlier and may be worth recording. I am sending the eggs for the Society's collection.

S. G. MONGA

MADHURIMA SOCIETY,
M. G. ROAD,
KANDIVLI (WEST),
BOMBAY-400 067,
September 7, 1982.

11. LABORATORY OBSERVATIONS ON THE INCUBATION PERIOD OF THE INDIAN BLACK IBIS *PSEUDIBIS PAPILLOSA* (TEMMINCK)

(*With a text-figure*)

Ali and Ripley (1968) have mentioned that there is no record of the incubation period of the Indian black ibis. In the course of our studies on Indian black ibis, we have been

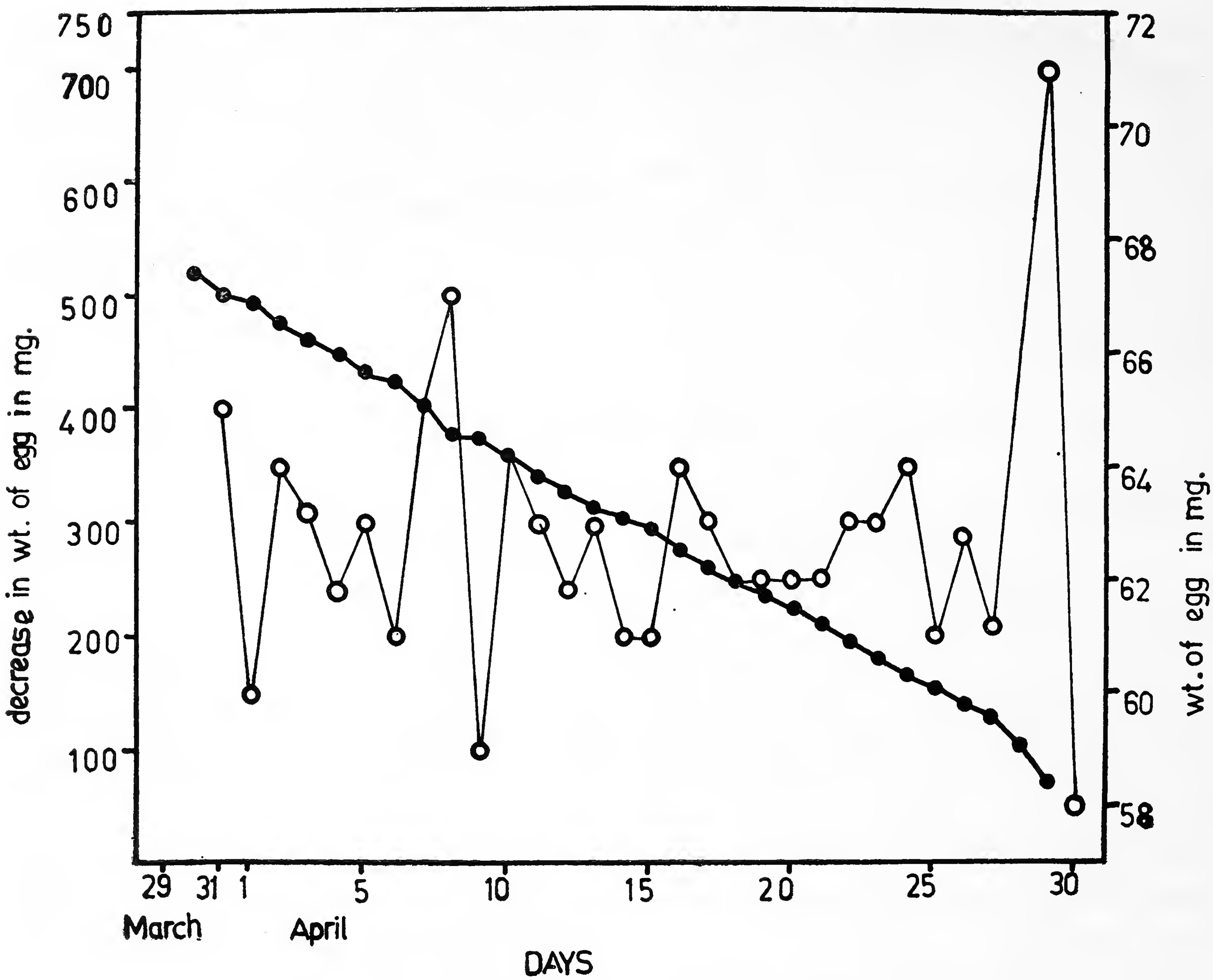

Fig. 1. Left ordinate (O) shows decrease in weight of egg in milligrams. Right ordinate (●) shows weight of egg in gms.

regularly checking a nest near the University Campus, Rajkot, from March 1982. Two eggs laid by the bird, however, were found missing. So the third egg which was laid on 29th March was brought to the laboratory, and was incubated using an oven. The temperature was kept constant at 37°C. One petridish of 10 cm diameter filled with water was placed at the bottom of the oven. The egg was rotated at regular intervals. It was weighed everyday in the evening.

The chick hatched on 30th April, at 0900 A.M. The incubation period was 33 days. The weight of the egg had decreased constantly, but the decrease in the weight was not linear (Fig. 1).

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SAURASHTRA UNIVERSITY
RAJKOT-360 005 (INDIA),
May 18, 1982.

C. SALIMKUMAR
V. C. SONI

REFERENCE

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12. SEASONALITY AND OCCURRENCE OF BIRDS IN THE EASTERN GHATS

The Errata on p. 240 of the *Journal* for April 1982 regarding the "Seasonality and Occurrence of Birds in the Eastern Ghats of Andhra Pradesh" 76(3) 1979 pp. 379-422 reminds me that when I wrote to Mr. Trevor Price, I also mentioned the improbability of the thousands of swifts (once counted as 8500) "undertaking daily migration throughout winter from the palm trees in the coastal plains to over the Ghats" being Palm Swifts (*Cypsiurus parvus*) as recorded (l.c., p. 410).

In March 1982 I was invited to the Eastern Ghats Environmental Seminar and one day we drove from Vizagapatnam to Lamasinghi. The paucity of Palm Swifts inspite of the abundance of the Borassus Palm (though all had their "heads" closely trimmed) was very striking. Could this lack of roosts have changed the habits of the Swifts and got them to collect elsewhere in large numbers ?

Or were the birds not palm swifts at all ?

75, ABDUL REHMAN STREET,
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September 11, 1982.

HUMAYUN ABDULALI

13. A CURIOUS EXPERIENCE WITH A SMALL MINIVET (*PERICROCOTUS CINNAMOMEUS*)

At about 9.30 a.m. on the morning of 8th May 1982, a chick, presumably unable to fly, was picked up on the ground behind our bungalow at Kihim, Alibag tal., Kolaba (now Rigadh) Dist., Maharashtra on an open piece of sandy ground under Casuarinas.

It was very lethargic in its movements and made no effort to escape handling by several people who were guessing at its identity.

We brought it to the house about 50 yards away and put in in an open cheese tin lined with Casuarina leaves. At 10 a.m. it drank 10/15 drops of milk delivered soaked in cotton wool. This appeared to liven it up. It now started to utter sharp high notes at regular intervals.

At noon it was brought outside into the open, it perched on the edge of the tin and was fed with bread crumbs soaked with milk. It continued to call.

At 12.30 p.m., just three hours after it was found, it fluttered out of the tin and fell to the ground about 10 feet away, to be immediately joined by the parents, who had presumably also been calling and had thus established contact. They indulged in a display of affection by fluttering close to the chick and nudging it right and left.

A jungle crow suddenly appeared and lurched towards the chick which was saved only by human intervention. The parents screeching loudly enticed the crow away by each trailing a wing in flight, keeping about 4 feet apart and 3 feet off the ground keeping just out of reach. The crow kept snapping at one or the other but they managed to draw him about 20 yards away.

The tin with the chick was then moved to an open table in a covered verandah. The parents re-established contact and started feeding it with insects. The crow appeared once again but was chased away by the parents helped by a pair of dayals who dive-bombed the crow, actually hitting the crow on more than one occasion. The Minivets also managed to remove a few feathers from the crow's nape making him a marked character in the neighbourhood.

For protection from the crow, the tin was placed inside a breed-cage 18″ x 10″ x 10″ and the hinged door left open. For some time both parents fluttered round the cage not daring to go in, but at about 1.30 p.m. they had overcome their fear and started feeding the chick. The food brought in consisted of green grasshoppers, white and coloured moths, large spiders, etc.

The feeding continued throughout the afternoon and evening, the parents soon having become accustomed to ignoring the constant movement of children, servants and others within about 5 feet of the cage. Our observation post was about 20 feet away and the chick and the cage were always visible.

During the course of the day the number of feedings was not counted but quite often the chick was satiated and refused to grab and swallow the food which was then taken away and eaten by the parents. Both parents appeared to be equally interested in bringing the food and while the pair would presumably go in different directions to look for food, it was seldom that both would come back carrying it. If one returned with food, it would wait until the other also arrived and they would then approach the chick together, one perching about 10 feet away at a slightly higher level, while the other did the feeding.

In the evening at about sunset the parents disappeared, the chick went to sleep and we shut the cage door.

On the following morning we opened the door when it was still dark. The parents arrived at about 6.25 a.m. and after making an initial contact and assuring that the chick was still there, went away and brought back the first morsel of food at about 6.40. The human interest and interference appeared to have increased a bit too much and we moved the cage about 15 yards away and hung it from a tree. The parents kept going to the old place with food, and failed to locate the new site. We therefore brought back the cage and fenced it off from the rest of the verandah with an old chik curtain. This appeared to be satisfactory and feeding was resumed. A palm squirrel appeared on the roof at about 7.30 a.m. and the female dived and chased it away. Throughout the morning the feeding continued and at about 11.30 a.m. the chick encouraged by the parents fluttered out of the cage. As it appeared helpless, we put it back but at about 12.15 p.m. the parents again wheedled it out and it flew for a short distance. It was then coaxed to enter heavier undergrowth and then they all disappeared.

In the short while that we had the bird under observation, the chick appeared to have grown to one-and-a-half times the original size and was certainly much stronger and more active when it flew away.

It was all a most interesting experience. The

Minivets lay 2 to 3 eggs at a time. What happened to the other chicks? Were they also being fed at the same time, and was there a final re-union?

C/o. N. FUTEHALLY & Co.,
19, BANK STREET,
BOMBAY-400 023,
August 12, 1982.

SADIQ A. FUTEHALLY

14. FREQUENCY AND DURATION OF INCUBATION OF THE EGGS FOR *AEGITHINA TIPHIA*

Material and Methods:

A pair of Iora were observed in their breeding activities from March 22, 1979 and April 27, 1979 in Tiruchirapalli, Tamil Nadu. Incubation of the eggs began with the laying of the first egg on March 27, 1979. There were two eggs in the nest, the second egg having been laid on March 29, 1979. Both the members of the pair were observed closely for two days — on April 4, 1979 and April 7, 1979 — from the first change of duty at 6.40 a.m. till the female sat on the eggs for the night at 4.30 p.m and 5.05 p.m. respectively. The nest with the two eggs was placed at a height of 20 feet from the ground at the parting of three outer twigs of a neem tree. The observation was made with a pair of binoculars 8 x 30 mm. Field 7.5°.

Results and Discussion:

The results of the observations made on April 4, 1979 and April 7, 1979 were tabulated and given in Tables 1 & 2.

The data for the first day showed that during the period between 6.40 a.m. and 4.30 p.m. the male was on the eggs six times with an average sitting duration of 53 mts and a total of 318 mts for the day. The female bird sat five times with the duration averaging at 54.4 mts and a total of 272 mts. The male had spent longer time on the eggs during the day than the female.

For the second day the data showed a trend similar to that of April 4, 1979, the male warming the eggs six times with a total duration of 325 mts at an average of 65 mts and the female performing it five times for 300 mts at an average of 60 mts.

It was obvious that there was alternate care of eggs by the two sexes. The brooding by the female less by a sitting and for shorter total duration during the day than the male did not indicate a shift to the male the burden of incubating. For assuming that the female rose up for the days at 6.40 a.m. on April 5, 1979 and April 6, 1979 the average duration in minutes for the night shifts would be 832.5 mts for the female.

Conversely, the male and the female were out of the nest alternately for a total of 272 mts and 318 mts respectively, the female foraging for 46 mts more than the male (Table 1). On April 7, 1979 they showed a similar trend, the female having been away from the nest for 25 mts more than the male (Table 2).

Could it be argued that the female was spending more time out of the nest to gather enough food to meet the energy requirement during the night for production of warmth for the eggs? A closer study of the tables suggests that the male bird had spent more time away than the female bird. On both the days under study, the female was away feeding six times. But the average time dura-

TABLE 1

DURATION (IN MINUTES) OF INCUBATION FOR EACH SITTING; 4-4-1979

Duration in minutes of incubation by the male	Time of arrival—male	Time of arrival—Female	Duration in minutes of incubation by female
	6.40 A.M.		
50		7.30 A.M.	
	8.05 A.M.		35
30		8.35 A.M.	
	9.35 A.M.		60
40		10.15 A.M.	
	11.25 A.M.		70
45		12.10 P.M.	
	1.24 P.M.		74
48		2.12 P.M.	
	2.45 P.M.		33
105		4.30 P.M.	
318			272

TABLE 2

DURATION (IN MINUTES) OF INCUBATION FOR EACH SITTING; 7-4-1979

Duration in minutes of incubation by the male	Time of arrival—male	Time of arrival—Female	Duration in minutes of incubation by the female
	6.40 A.M.		
55		7.35 A.M.	
	8.10 A.M.		35
30		8.40 A.M.	
	9.40 A.M.		60
45		10.25 A.M.	
	12.00 Noon		95
100		1.40 P.M.	
	2.25 P.M.		45
25		2.50 P.M.	
	3.55 P.M.		65
70		5.05 P.M.	
325			300

tion for which she was away from the nest was 53 mts, 1.4 mts less than for the five foraging trips of the male for the first day. The corresponding time scales for the female for the next day were 64.16 mts and 4.16 mts respectively. It was evident that the male was spending more time, on the average, on foraging than the female though the number of trips he made was fewer by one than his mate. This might be a necessary exercise for him

because he had to sit on the eggs six times the total duration of which exceeded that of the female's.

Conversely, the data also suggests that the length of time the female spent on foraging increased from about noon until her sitting on the eggs for the night. The total period for the second set of three foraging for the first day was 198 mts which was 78 mts more than that for the three earlier trips that day. The corresponding values for the second day were 195 mts and 65 mts. It appears as though the female was preparing for the night's brooding, storing enough energy in her body. This argument, however, has the disadvantage that it does not consider the fact that the male was free to forage from the moment he was last relieved from duty by the female at 4.30 p.m. and 5.05 p.m. on the two days of observation. Hence it cannot be said with certainty that the female gathered more food for the nights than the male did for his roosting.

Conclusion:

The male and the female iora share the duty of incubating the eggs, both taking turns to sit on them. During the day the male incubates for longer duration than the female. The female sits on the eggs for the night.

The male appears to spend more time on the average on collecting food than the female. However the female incubates for much longer duration when the day and night sittings are taken together. Nevertheless, it is not certain if the female accumulates and spends more energy on incubation than the male does. Two more thoughts that occur and need verification are that (1) the periodic shifts might be to dissipate the extra thermal energy generated during incubation; and (2) the out-of-the nest sojourn may have the additional purpose of keeping themselves oriented to the familiar nature environment.

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December 22, 1981.

15. *HYPSIPETES MADAGASCARIENSIS SINENSIS* (LA TOUCHE): A FIRST RECORD FOR INDIA

In late 1981, my wife and I joined Dr. Salim Ali and colleagues from the Bombay Natural History Society in an ornithological survey of the Namdapha Wildlife Reserve, Tirap District, Arunachal Pradesh. On 20 December 1981, we were fortunate to obtain a specimen of an apparently adult female of the bulbul *Hypsipetes madagascariensis sinensis* (La Touche), a first record for India.

The Black Bulbul, *H. madagascariensis*, is a wide-ranging species that occurs from Madagascar to Afghanistan, India, southeast Asia, China and Taiwan (Deignan 1960). Sixteen subspecies are currently recognized (ibid.), and of these, four have been recorded from India: *psaroides, ganeesa, humii* and *nigrescens* (Ripley 1982). The resident population in Arunachal Pradesh is *nigrescens*, a bird that is

mostly slaty blue-grey with a black crown, malar streak, nape and tail. The bird that we collected differs markedly from *nigrescens*, and closely resembles, in plumage and dimensions, specimens of *sinensis* examined at the U. S. National Museum and American Museum of Natural History (Table 1). Unlike *nigrescens*, our bird is rich blackish with slight iridescent highlighting on the dorsum, and fine scalloping of pale grey on the belly and vent. In this respect, it agrees with the known female plumage of *sinensis*, and no other (Mayr 1941). The male of the subspecies *ambiens* is similar, but the female *ambiens*, which we examined, is grey ventrally, very distinct.

TABLE 1

MEASUREMENTS OF *Hypsipetes madagascariensis* (FEMALES ONLY)

Subspecies	N	Wing	Tail
Indian Specimen	1	122	93.5
sinensis	5	116–129	92.5–103
ambiens	*	116–121	97–103

* Measurements by Mayr (1941), at least 5 specimens included.

A number of well defined local isolates of *H. madagascariensis* have evolved in the mountainous region of SW China and North Burma (Mayr 1941). *Sinensis* is one of several subspecies whose breeding range occurs in this area. To date, *sinensis* has been recorded breeding in NW Yunnan and adjacent Hsikang (Salween-Mekong Watershed), and it has been recorded as a migrant dispersing into Laos and Thailand. The new record in eastern Arunachal Pradesh represents a range extension of 200 km to the west of the bird's known breeding habitat. Considering the known dispersal capabilities of *Hypsipetes madagascariensis*, this distance is not extraordinary.

Given that the population of *ambiens* is recorded as breeding in the area between the range of *sinensis* and Arunachal Pradesh, one might expect to find the occasional individual of this other subspecies occurring in north-eastern India, as well. Further ornithological surveys of this frontier region would be profitable.

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S. A. HUSSAIN

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BOMBAY-400 023,
June 22, 1983.

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16. THE DIAGNOSTIC PLUMAGE CHARACTERS OF THE RED-HEADED BABBLERS *STACHYRIS RUFICEPS* AND *S. RUFIFRONS*

In 1847 Blyth described a new small babbler, *Stachyris ruficeps*: a drab olive bird with a slender tapering bill and rufous cap. He stated that the crown was ferruginous, the lower parts whitish with a fulvous tinge on the sides of neck and breast, and the chin and mid-throat white. In his catalogue of birds of the Asiatic Society's museum (Blyth 1849) he indicated that the holotype was a specimen from Darjeeling collected by C. S. Bonnivie. A similar description was used by Horsfield and Moore (1854) in their catalogue of birds of the East India Company's museum, based on specimens collected by B. H. Hodgson.

Hume (1873) described a new species, *S. rufifrons*, from Burma. It was differentiated from *S. ruficeps* in having, *inter alia*, the rufous of the head extending to the occiput, and in lacking the yellow tinge to the underside which Hume stated was present in *ruficeps*. Harington (1915) described the subspecies *S. rufifrons ambigua* from Assam, and commented on the published descriptions of *S. ruficeps*, querying the reference to a white throat. Subsequently *S. rufifrons ambigua* has been found occurring north to the foothills of Sikkim (Ali & Ripley 1971).

On present information and specimens there appear to be two sibling species. The more northerly Red-headed Babbler *S. ruficeps* occurs in Taiwan, through much of China and south into northern Vietnam with an isolated population in southern Vietnam, into the hills of north-west Burma and the Indian border, and through the eastern Himalayas. The Red-fronted Babbler *S. rufifrons* is a southern species occurring from Borneo and Sumatra, north through Malaya into northern Thailand and southern Burma, through the hills of western and northern Burma, and along the Himalayas.

I have not found any evidence to support Deignan's proposal (Peters 1964) to regard *ambigua* and *rufifrons* as separate species. E. C. Dickinson has suggested (*in litt.*) that Deignan was influenced by problems of apparent sympatry in northern Thailand (Deignan 1945) which were resolved by retaining *S. rodolphei* Deignan 1939 as a full species. However, in Peters' Checklist Deignan (1964) lists a series of apparently allopatric subspecies of *rufifrons/ambigua* but divides them into two species. There is material of both in the British Museum (Natural History) and I can find no characters for such a specific separation, nor any statement by Deignan concerning the specific characters of his *S. ambigua* which might justify such a separation.

Where *ruficeps* and *rufifrons* overlap in general range there is usually an altitudinal separation with *rufifrons* at lower altitudes. However, there may be some degree of altitudinal overlap and in the collection of the British Museum (Natural History) there are specimens of both species labelled Darjeeling.

The two species are generally similar but two diagnostic characters are apparent. *S. rufifrons* has a chestnut cap extending back no further than the hind-crown and usually with some indistinct dark streaking along the feather shafts, while *S. ruficeps* has a uniform chestnut cap extending right back to the nape where it merges with the mantle, not "sharply defined" from it as stated in Ali and Ripley (1971). *S. rufifrons* has a white throat, usually with some fine blackish streaks along the feather shafts, and this is separated from the rest of the underside by a transverse zone of

slightly rufous buff colour which also borders the throat. *S. ruficeps* has a very pale throat, usually with a faint yellow tint, which merges gradually into ochraceous-buff on the upper breast and cheeks. The yellowish suffusion of the underside and back, making the latter appear greener, is referred to in most recent literature but is variable in character, and is absent over most of the underside in some Chinese subspecies.

Mr. H. Abdulali has recently queried (pers. comm.) Blyth's description of the type of *S. ruficeps* as having a white throat when it should be pale yellow, the white throat being regarded as a character of *S. rufifrons.* I have not been able to trace the present location, if any, of the holotype of the former species. Horsfield and Moore (1854) used specimens collected by B. H. Hodgson which in the absence of the holotype of *S. ruficeps* provide information on the type of material available at the time. Some of these Hodgson specimens from the East India Company's museum are now in the collection of the British Museum (Natural History) and these lack a yellow suffusion, and are therefore white-throated.

This might be attributed to later fading and exposure to light, but a specimen of *ruficeps* from Hodgson which appears to have come straight to the museum and was registered in 1859 (no. 1859. 3.4.267) is wholly without yellow colour and has a white throat, while other specimens collected only a little later still retain the yellow. It is possible that a preservation technique was used which affected the lipochrome pigments but not the melanins. There is therefore a strong possibility that Blyth's type specimen may have lost its yellow colour prior to being described. The fact that he refers to fulvous colour at the sides of the throat and breast, and does not refer to a rufous-buff transverse zone on the upper breast which would have been present in *rufifrons,* appears to confirm that the specimen he described was in fact *ruficeps.* His reference to a white throat would not therefore affect the nomenclature of these species.

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17. BEHAVIOURAL RESPONSE OF A MALE MAGPIE-ROBIN (*COPSYCHUS SAULARIS* SCLATER) TO ITS OWN SONG

The observations were carried out during May 1982 at Pazayannur village in the Trichur district of Kerala. A pair of magpie-robins had nested in a bulbless street lamp-shade and the favourite singing perch of the male magpie-robin was the electric wire leading to the lamp post. The recording of the song was done by suitably placing a battery operated portable cassette tape recorder with a built-in microphone on first floor veranda of a building with grills almost on all sides which permitted birds to enter and leave easily. From this vantage point an excellent view could be obtained of the lamp post nest of the magpie-robins as well as a 50 year old peepul tree located 60 feet from the veranda but whose branches reached to within 20 feet of it. During the period of this observation the peepul tree was fruiting and was frequented by many species of birds.

The recordings included the calls and songs of all the singing birds of the vicinity, but the song of the male magpie-robin predominated especially during early mornings. During a test replay of about an hour's recording at very low volume the male magpie-robin sitting on the electric wire about ten feet away was found to puff up on hearing its own song. This was followed by a direct flight towards me when I was holding the recorder, and a few swift criss-cross flights close over my head with pecking attempts.

In order to see the bird's reaction to other birds singing its song, three dummy bird models, one resembling as closely as possible a magpie-robin and the other two resembling a myna (*Acridotheres tristis*) and a black drongo (*Dicrurus adsimilis*) respectively were set up prominently on the grill at 15 feet intervals and the recorder replaying the male magpie-robin song was placed close to each dummy one after another. In these experiments the magpie-robin tended to ignore the dummies altogether.

In the first instance the robin landed within three inches of the recorder, ignoring the dummy robin, puffed up several times while hopping around the recorder subjecting it to close scrutiny. No attempt was made to attack the recorder itself. With the other two dummies the reaction was progressively less pronounced with the bird appearing in the balcony in a puffed up state but without bothering to examine the recorder further. These observations were made from a concealed place behind a window of a nearby room. A complete disregard for the visual image (stuffed bird) and a keen attraction for the source of the sound was clearly evident.

Prolonged observations showed that the behavioural response of the male magpie-robin to its own song had three phases. The immediate response was anger with the bird puffing up and flying straight towards the source of the song in a clearly aggressive manner. On the replay being continued the initial anger and aggressiveness was followed by a period of confusion with the bird perching and flying restlessly in the vicinity of the source while attempting to sing. Repeated exposures to its own song accustomed the bird to it and was even found to stimulate it to sing. Henry (1975) has mentioned somewhat similar behaviour during encounters between rival male magpie-robins with the birds attempting to outsing each other. In the present observations the prolonged exposure to its own song acted only as a stimulant for the male magpie-robin to

sing. Such artificially stimulated songs were of shorter duration and seemed less inspired. There was no attempt to outsing the tape recorder. Whether this muted behavioural reaction was due to the bird having recognised the song as its own or having realised the mechanical origin of the song remains to be found out.

Only the fixed station song (Salim Ali 1960) that elaborately was sung by the male magpie-robin in the mornings between 5.30 and 6.30 were played back in these experiments.

I am grateful to Dr. Rachel Reuben, Deputy Director, Vector Control Research Centre, Pondicherry, for suggestions.

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18. MOUSE, A NEST-PARASITE OF BAYA WEAVER BIRD (*PLOCEUS PHILIPPINUS* L.)

(*With three text-figures*)

During my field surveys for indigenous palm species, I came across a few Baya weaver bird (*Ploceus philippinus*) colonies nesting on telegraph wire (Fig. 1). Baya nesting on telegraph wires or on live power lines have been recorded by Ambedkar (1970), Betts (1952), Davis (1971, 1978) and Kirkpatrick (1952). A colony on telegraph line noticed by Devadanam, Ramnad District, Tamilnadu in early July 1981, revealed a curious phenomenon. By May-June, the nests were deserted by the weaver birds since the breeding season was already over by them. But a number of nests were found parasitized by a species of mouse (*Mus* sp.) common in Tamilnadu, for its breeding purpose (Fig. 2). Watching about a dozen semi-adult mice moving around the deserted Baya nests was a spectacular sight. To satisfy my curiosity, I pulled down some nests with a bamboo pole, when alas! dozens of still younger mice fell down from different nests in the sugarcane field below. However, none of them could walk along the wire even for a short distance. Eventhough I have not seen an adult passing along the wire in order to have ground contact for foraging, I was told by eye witness that the mice move from the nests to the ground and vice-versa only during nights. In the colony which I watched, the mice had to move along the wire to a distance of not less than 10 m to reach the nearest pole for climbing down. Thus, the adult mice seem eminently adapted to climbing posts and walking on wire. Moreover, the adult mice have no need to carry food for the young ones, which would

have necessitated more hazardous walks over the thin wire.

The African weaver birds whose nests have been parasitized by other animals including birds have been explained in detail by Friedmann (1960). Many ploceine species have been found to carry out nest-building activities to excessive proportions by building in and out of season. These out-of-season nests, apparently not being used for breeding, are deserted prematurely. Many of these nests offer ideal shelters and breeding place for several species of animals especially birds like Munia (*Lonchura malabarica* L.), members of estrildines, as well as squirrels (Salim Ali 1931, 1977; Ambedkar 1970; Friedmann 1960). Mice are yet another nest-parasite of the Baya weaver bird.

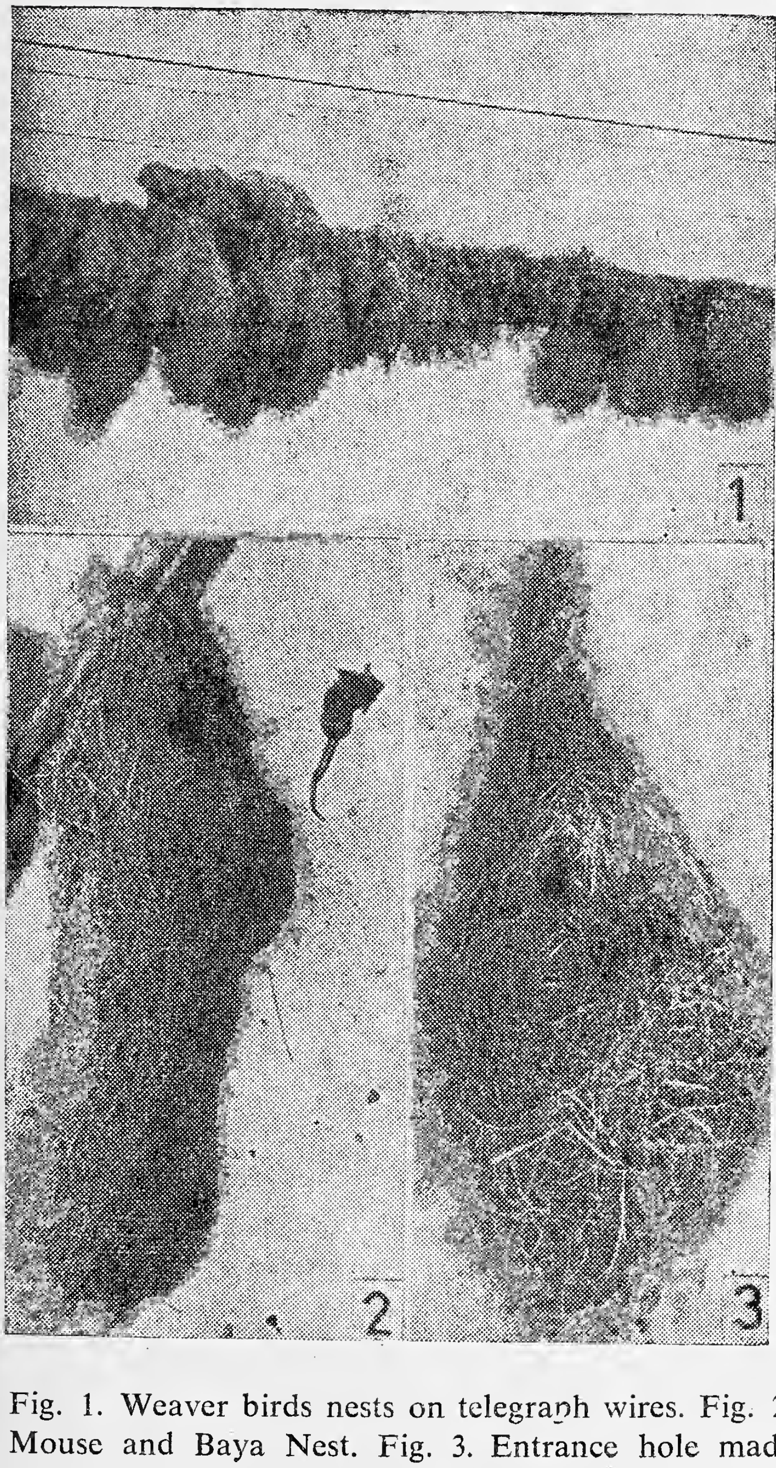

Fig. 1. Weaver birds nests on telegraph wires. Fig. 2. Mouse and Baya Nest. Fig. 3. Entrance hole made by mouse.

From a study of the nesting sites of the Baya Weaver, Davis (1978) is of the opinion that the bird gives maximum importance to the safety of the nest against predators, wind and rain. Only next in importance, is the availability of nest-weaving material around the host tree. Therefore, attaching nests on telegraph or power lines is presumed to be for greater safety against predators even though it is more vulnerable to wind damage. In order to overcome this disadvantage, the bird ingeniously changes even the structure of the nest by dispensing with long suspension and entrance tubes. Nevertheless, even these telegraph or power lines are not spared by mice and perhaps some snakes. The mice do not harm the birds or the nest contents. But they merely make use of the deserted nest for their breeding purpose. The mouse does not move over the complete nest to enter through the normal opening at the bottom, but it makes a small hole at the top or on a side of the nest through which it enters (Fig. 3). Perhaps the mice devour any dead chick or rotting egg still left in some of the nests. It is possible that in some localities bigger species of rodents could also reach such nests during breeding season and destroy some eggs or young ones.

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19. FIRST RECORD OF THE FRESHWATER GREY MULLET, *RHINOMUGIL CORSULA* (HAMILTON) FROM MAHARASHTRA

This is the first record of *Rhinomugil corsula* (Ham.) from Maharashtra State. The fishes were found in Bhima and Nira rivers and a few of their tributaries like Ghod and Velvandi. Probably the water depth plays an important role in their limited distribution. The fishes have a peculiar habit of keeping their eyes, head and anterior portion of the body out of water and swim in small shoals. This ability to see out of water makes them hard to catch. Moreover these large river fishes have been seen to survive adverse conditions of temperature and limited food supply.

INTRODUCTION

While surveying the Fauna of Pune district for the Western Regional Station, Zoological Survey of India, we collected *Rhinomugil corsula* (Ham.) from the Bhima river and some of its tributaries.

As a perusal of literature (Menon & Jayaram 1977, Jayaram 1981) confirmed that no previous record of this fish existed from Maharashtra, it was decided to conduct a thorough survey in Pune district primarily for studying the occurrence and distribution of this fish in Bhima river and its tributaries which form part of the Krishna river system.

MATERIALS AND METHODS

Almost all the rivers, streams, etc., passing

through Pune district and ultimately meeting Bhima river were surveyed during March-July 1983. The specimens were collected by using cast nets along the banks of the rivers. The fish has aerial vision due to dorsally situated eyes (which it keeps above water) and thus easily escaped capture in all 42 stations that were surveyed.

The fish specimens collected from the surveys were identified with the help of Menon & Jayaram (1977) and Jayaram (1981), and identification confirmed at Calcutta.

Occurrence and Distribution

The first record of *Rhinomugil corsula* (Ham.) is of Hamilton (1822) from the Gangetic river system. Day (1889) mentioned rivers and estuaries of Bengal and Burma as its habitat. Recently Menon & Jayaram (1977) recorded for the first time its occurrence in the Cauvery river system, where they found it along the entire stretch of the river system. However there is no record from Maharashtra.

Field observations show that *R. corsula* has been located in Nira and Bhima rivers almost upto their origin. Almost all the tributaries of Nira and Bhima were devoid of this fish except Ghod river (a major tributary of Bhima) near Chinchani dam. In Mula & Mutha rivers too these fishes were not seen. The probable reason for its absence may be due to less water depth in these tributaries which hinders easy movements. Jayaram (1981) too has noted its presence in large rivers only. Moreover Mula & Mutha rivers are infested with water hyacinth which grows profusely and covers the entire water surface which also hinders their movement near the surface.

Panshet, Mulshi and Pawna dams constructed on Mutha, Mula and Pawna rivers respectively were also devoid of this fish, but it was present in large numbers in Ujni dam on Bhima river and in Bhatgar dam on Velvandi river, a major tributary of Nira near Bhor.

As carp spawn and fry are brought from Calcutta by the State Fisheries Department for releasing in the waters of Maharashtra State, it is quite possible that small numbers of *Rhinomugil* sp. spawn or fry might have inadvertently come along with these carp fry. Similar accidental stocking of this fish has been reported by Ranganathan & Natarajan (1969) in Krishnagiri and Sathanur reservoirs in Tamil Nadu.

Habit and Habitat

The fishes have a peculiar habit of swimming in small shoals near the water surface with their eyes, head and anterior portion of the body out of water. This aerial vision gives them a fair chance of escaping capture. Whenever danger threatens, the whole shoal dives underwater and reappears at a safe place farther away after some time. They have also been observed skipping on water for a short distance to escape netting. These fishes are usually found near the muddy banks of rivers in groups of 20-30.

During the summer of 1983, Bhima river was dry almost the entire length except for a few pools of stagnant water. One such pool of water of about 1½ metre depth near Talegaon Dhamdhere had about 20-25 fish (length upto 37 cm) swimming in separate groups. It is remarkable that these large river fish survive in such adverse conditions of temperature and limited food supply.

Little is known about the breeding habits of the species. Menon (pers. comm.) has mentioned that this fish multiplies fast and that the Cauvery river above Krishnarajasagar dam, where the Hemavathi joins the Cauvery,

has presently innumerable *Rhinomugil.* Although this situation has not developed here, it is imperative to start preventive measures to protect indigenous species from being eliminated by competition for food and space.

The fish has good culinary value, but its commercial exploitation is not feasible in the present conditions as it escapes netting due to its ability to see out of water. Gill and cast nets have not given promising results. It is quite possible that this fish might have been accidentally introduced together with the carp frys in other major rivers of Maharashtra State. Further surveys are in progress.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for allowing us to publish this note. We are also wish to express our thanks to Dr. A. G. K. Menon for his help and advice. We are also grateful to Dr. K. C. Jayaram, Joint Director, Zoological Survey of India, Calcutta, for confirming the identification and also for critically going through the MS. Thanks are also due to the Pune regional office of Maharashtra State Fisheries Department for their help.

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20. PRELIMINARY OBSERVATIONS ON THE MIGRATORY BEHAVIOUR OF THE GARHWAL HIMALAYAN MAHSEER

(*With a text-figure*)

The observations revealed a peculiar pattern of migration in the Garhwal Himalayan mahseer *Tor putitora* (Ham.). The parent population was observed to inhabit the Ganga at the foothills of the Garhwal Himalaya while new recruits and the young fish inhabit the shallow spring-fed hill streams of this region. The fish was observed to frequent snow-fed streams or rivers for a span of 3-4 months i.e. between March-April and June-July, from where the brooders moved towards suitable spawning grounds and the non-brooders re-

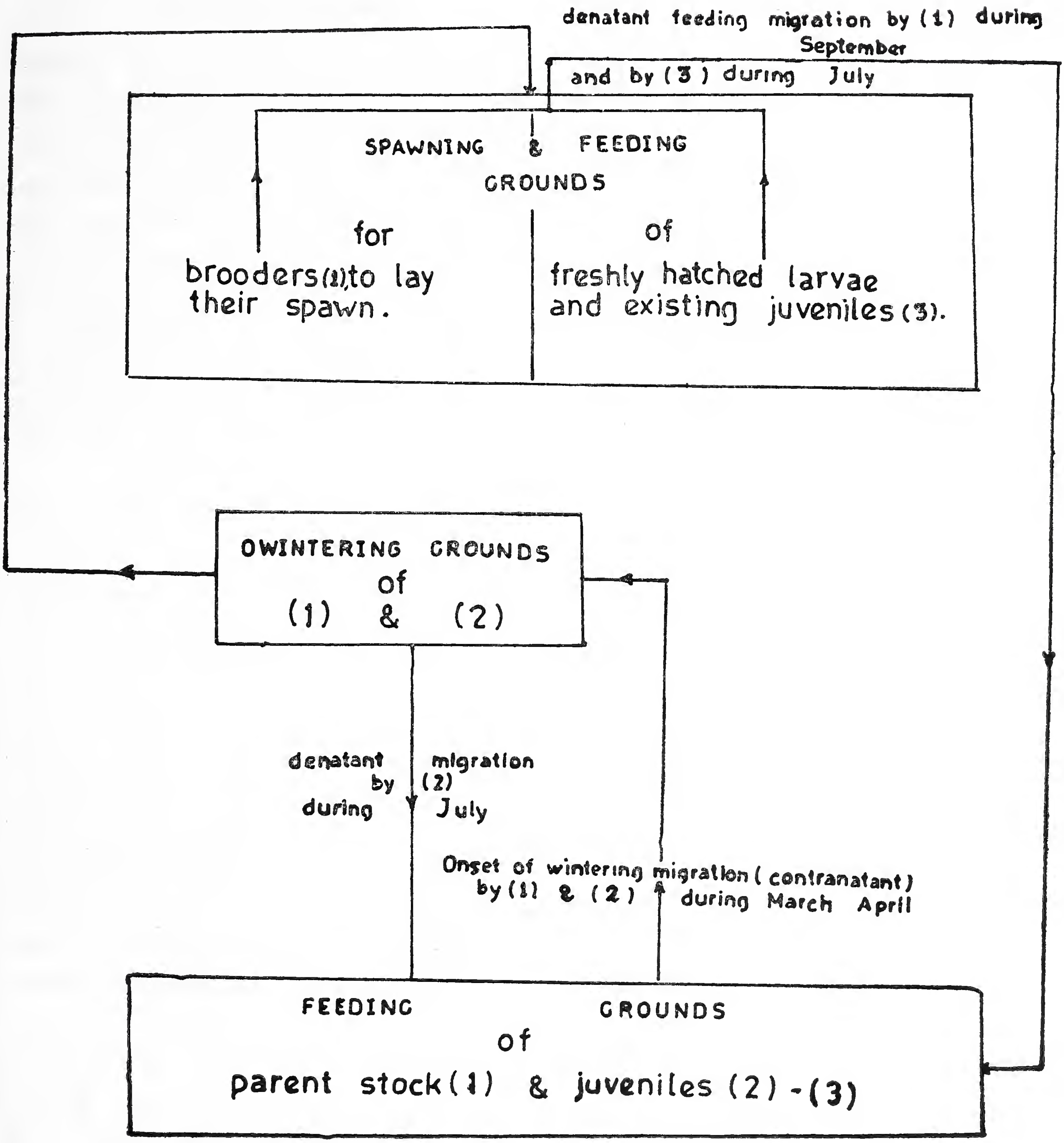

Fig. 1. Diagrammatic representation of the migratory pattern exhibited by the Garhwal Himalayan mahseer.

turned to the foothills during July. The mature fish returned to the foothills only after laying their spawn. This descent was observed during September. The earlier part was considered to be wintering migration while latter as spawning migration. The fish thus exhibited tri-phased migration.

Further, it was found to possess separate feeding, breeding and overwintering grounds, and migrates from one to another to ensure the survival of the species by maintaining the food supply. The water temperature was observed to govern the phenomenon of tri-phased migration, high turbidity being a critical factor.

Introduction

Feeding and breeding are the two most important activities while migration, in some species of fishes is an adaptation which usually links them and ensures their existence, survival and numbers. Naturally, migrations like any other adaptive property of the species, have developed in the process of evolution and the basic factor, primarily for the freshwater fishes being insufficient food supply (Nikolskii 1963). According to Nikolaev (1958 a & 1958b) and Nikolskii (1961a & b), the food supply of the parent population determines not only the fecundity but also the quality of the sexual products and thus the viability of the off-springs. Evidently, if both the parents and their young ones have same feeding grounds the competition for food will increase and lead to scarcity of food and ultimately to decrease in fecundity and viability of the off-springs.

[1] *Tor putitora* matures in four stages, 'Immature' (Ist), 'Maturing virgins' (IInd), 'Ripening' (IIIrd) and 'Ripe' (IVth).

Migratory Pattern

The parent population of the Garhwal Himalayan mahseer along with the juveniles nearing maturity inhabit the Ganga where they feed, grow and attain maturity. The phenomenon of contranatant migration commences somewhere in March-April when their shoals appear for the first time in the snow-fed tributaries of the Ganga (Fig. 1). The fishes within 20.0-70.0 cm range, comprising mainly of individuals in second and third stages of maturity[1], were in abundance while those in fourth stage of maturity were very rare. They frequented these tributaries upto June-July, thus covering a span of 3-4 months.

The first phase of migration comes to an end during July and the second phase sets in which bifurcates at this juncture. In the first part of the second phase the mahseer juveniles, which are common inhabitants of the shallow spring-fed hillstreams, move into torrential snow-fed rivers or streams when the former swell due to sudden influx of water during early monsoon. Most of them measure below 20.0 cm in length and occur almost regularly in the daily catches. They join the shoals of juveniles which had migrated upwards, and migrate along with them towards the foothills. The fact that the Ganga is a vast water body providing an appropriate environment for the young to grow and attain adolescence, as compared to the shallow streams which supplement the descent of 'immatures' into the snow-fed rivers like Alaknanda and Bhagirathi and then into the Ganga. Simultaneous to the migration of the juvenile stock commences the movement of the brooders from the Ganga and its snow-fed tributaries into the spring-fed streams possessing suitable spawning grounds. The latter were also observed to serve as the feeding grounds of the new

recruits and youngest juveniles. With the onset of the spawning season sets in the second part of the second phase of migration. This spawning migration is initiated somewhere in July and continues upto September after which the spent fishes exhibit denatant migration and return to the foothills. This, of course is the third and the concluding phase of the migration.

Factors influencing migration:

It is evident from the above observations that the fish exhibits two types of migration. Based on the purpose of migration they can be classified as 'spawning' and 'wintering'. Both of them are regulated or rather influenced by changes in the water temperature for the onset of wintering migration coincided with the general rise in the temperature. The water temperature in the Alaknanda was observed to achieve a maxima during May (18°C) which implies that the temperature in Ganga must be higher to the extent that mahseer cannot withstand it. Similarly, the denatant migration of the juveniles during July coincided with the lowering of the water temperature in the Alaknanda. Naturally, they cannot tolerate high temperatures of the Ganga and move towards cold waters of the Alaknanda and Bhagirathi, nor can they tolerate low temperatures of these snow-fed rivers and move towards warm waters of the Ganga. The fish is apparently 'sternothermal' in nature, as is *S. richardsonii*, another coldwater species of this region (Nautiyal *et al.* 1982).

The spawning migration, too, is influenced by fluctuations in the water temperature but sudden influx of the water carrying huge amounts of silt seems to be the major factor effecting migration of the brooders.

Adaptive significance

All the phases of migration are of adaptive significance. To begin with, the spawning migration ensures the survival of the species by maintaining the food supply in these rivers and streams. The migration of the 'immatures' from the spring-fed tributaries to snow-fed and that of wintering juveniles from the foothills to the upper reaches and back, too, is undertaken to maintain the food supply, which is scarce in these tributaries. In case of those which move away from the spawning-cum-feeding grounds it ensures food for new recruits which are voracious feeders (Nautiyal & Lal, in press). The tri-phased migration of the Garhwal Himalayan mahseer is obviously due to insufficient 'basic food'.

Apparently, the pattern of migration involves movement of the mahseer from the feeding grounds to the wintering ones and then to the spawning grounds. Since the upper reaches of the Ganga and its tributaries are not rich in 'basic food', the migration of *Tor putitora* is of adaptive significance from the viewpoint of limited food supply.

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21. THE SPIDER AS BEE ENEMY

(*With a text-figure*)

INTRODUCTION

During routine inspection of apiary in spring honey flow period, occasionally spiders are spotted which seem to mean no harm. Their webs appear amidst the fencing shrubs and undergrowth. With the commencement of the monsoon season however, webs along with the spiders start appear in greater numbers in the apiary which soon form an invisible wall all around from ground to tree top levels. A close look at the web during monsoon and autumn period revealed *A. mellifera* honey bees caught in them while the others already devoured and discarded were seen on the ground below the webs. The spider webs were also a source of nuisance in the apiary during inspection work. Out of curiosity, observations were initiated on the nature and extent of damage to honey bees caused throughout the year and possibilities of some control measure.

OBSERVATIONS

Spider webs were located amidst and over the fencing bush foliage, amongst the apiary shrubs at 15 feet from ground level and also among the surrounding trees upto 40 feet height.

Average web size was found to be 3.5 feet across and were either round, square or pentagonal in form, though other forms also existed. Some spiders occupying these webs were caught, preserved and sent to Department of Zoology, Punjab Agricultural University, Ludhiana where they were identified as *Nephilia kuhlii.* The pattern of the webbing around the apiary was such that any forager or young bee in orientation flight was certain of getting trapped since most of them were right in the flight path of the foragers. However, it was observed that foragers which took off from the colony flew at high speed and pierced the webs to the other side without any harm while others coming laden with pollen or nectar to the hive were caught in the webs owing to their slow speed. In a separate observation taken in a private *A. indica* apiary plagued with a similar problem, comparatively less number of foragers were trapped in the webs by virtue of its being extremely agile.

Five clean webs were kept under constant scrutiny all through the day for studying the feeding behaviour of the spider. Total number of spiders in the apiary was worked out considering the number of webs scattered around. When trapped in the web, the bees tried to get free but got more perfectly entangled. This struggle by the bees was carefully watched by the spider which maintained its distance from the unfortunate victim. When the bee gave up the struggle the spider started moving towards it and carefully wrapped it up like a cocoon in a freshly spun silk web. Such cocooned bees were then suspended on one side of the web and the spider returned to its previous position, maintaining a close vigil. On an average, 10 foragers were got trapped by evening in clean webs every day. Feeding on the trapped bees continued from morning till evening. Whenever hungry, the spider approached the cocooned bees, cleaned off the silken threads and ripped open the thoracic and abdominal portion to feed on the stomach and intestinal contents. During feeding, the bees exhibited some movements but soon perished. Such devoured bees were later cast to the ground by the spider.

The apiary consisting of 50 well managed colonies of *A. mellifera* had 71 major webs within the apiary premises and 132 webs on the fencing shrubs and amongst the tree foliage. Thus, with over 200 spiders comfortably ensconced in their webs in the apiary under study, roughly 2000 foragers were lost in a day. This worked out to a loss of 40 bee foragers in one single colony. Considering the production of nearly 800 bees during this period every day in one colony the loss accruing to spider damage alone amounted to 5 per cent of the total bee production (Table 1). However, this, coupled with the damage caused by major enemies like wasp, endoparasitic mite *Tropilaelaps clareae* and birds, the colony strength soon dwindled. The loss is often colossal considering the fact that this is a scarcity period in Kangra valley of Palampur and artificial feeding has to be resorted to, so that egg laying work is not hampered in a colony. With the winter approaching, the colony situation rapidly deteriorated, calling for utmost care in organising sound management practices.

TABLE 1

EXTENT OF DAMAGE (%) TO HONEY BEES*

		Critical destructive period in a year					
Year	Bees	June	July	August	September	October	November
1978**	*Apis mellifera*	<1	1.25	3.75	4.38	5	<1
	Apis indica	—	<1	1.25	2.50	3.13	2.50
1979***	*Apis mellifera*	—	<1	2.50	1.25	3.75	1.88
1980***	*Apis mellifera*	—	<1	3.13	1.50	4.38	<1

* Observations based on 5 spider nests
** Untreated
*** Treated

In a separate experiment with *A. mellifera* in another apiary, carbaryl 50 WP @ 0.05

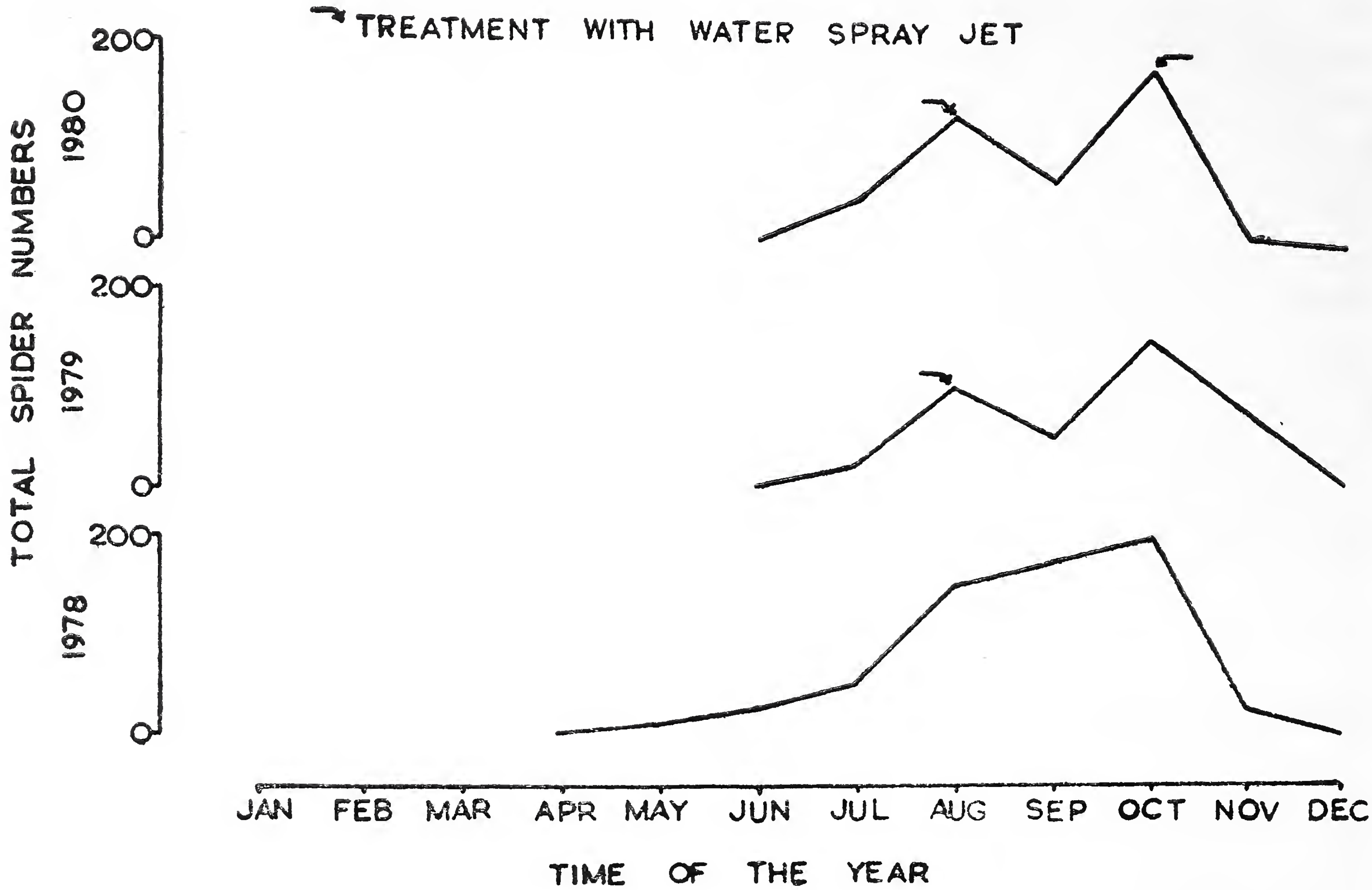

Fig. 1. Spider population throughout the year.

per cent was found to give effective check against spiders among other chemicals when sprayed at dusk after all the bees were safely inside the hives. By morning the effect of the insecticidal compound had worn off since no undesirable bee behaviour was noticed and normal colony work in all the hives progressed satisfactorily. However it was a difficult task to get rid of the spiders by resorting to chemicals for fear of careless and untimely use of the chemical by field workers. Besides, even if the spiders were killed the webs would still be a nuisance to the bees. This problem was effectively tackled by washing down the spiders along with their webs with a quick water-spray-jet. This work was done on a bright, clear and sunny day and many of the spiders receiving direct water-spray jet were paralysed and later killed. No new webs came up for good part of the season later.

Observations were again resumed the next year 1979 (Fig 1). It was found that the spider activity did not show up as early as on the previous year. It started late during July, picking-up by August and their activity was confined to certain isolated areas in the apiary. Water-spray jet treatment was given during August and consequently the population level showed a rapid decrease. However, the population level again shot up to 150 during October and the decline by November was extremely slow. This simultaneously resulted in continued loss to the bee colonies prior to winter. In the third year of 1980, spider popu-

lation showing a threatening level during August was curbed through the first water-spray jet treatment. Another treatment was resorted to during October as a result of which the problem was taken care off in good time. During this year, some of the trees, shrubs and other plants were pruned and fencing area cleaned. The distance between bush to bush was also increased so as to deny their use for webbing.

To contain the spider menace thus, it was observed that, apart from maintaining clean surroundings, use of water-spray jets once during peak time in August and another during late autumn season gave a safe, clean, economical, efficient and sure method of control.

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22. NEW RECORDS OF APHIDS (HOMOPTERA: APHIDIDAE) FROM UTTAR PRADESH

The aphid fauna of Uttar Pradesh is comprised of 169 species belonging to 79 genera. Further exploration in the hills of Kumaon Range of the state during the period 1979-'80 17 more species were recorded for the first time from the state. With the present communication the aphid fauna of Uttar Pradesh numbers 186 species.

The material of the species reported are in the collection of Entomology Laboratory, Department of Zoology, University of Calcutta, Calcutta 700 019.

Capitophorus hippophaes mitegoni Eastop: 2 apterae viviparae ex. *Clematis buchaniana,* Nainital, 4.xii.79; many apterae viviparae and 1 alate vivipara ex. *Polygonum barbatum,* Bageshwar, 21.iii.80.

Cavariella konoi Takahashi: 15 apterae viviparae ex. *Salix babylonica,* Nainital, 16.iii.80.

Ceratovacuna silvestrii (Takahashi): 8 apterae viviparae and 9 nymphs ex. *Bambusa* sp. Almorah, 8.xii.79.

Diphorodon cannabis (Passerini): 5 apterae viviparae and 2 nymphs ex. *Cannabis sativa,* Almorah, 8.xii.79.

Greenidea longirostris Basu: 1 alate vivipara ex. indet plant of Palmaceae and ex. *Quercus* sp., Nainital, 13.iii.80.

Hyperomyzus lactuceae (Linn.): 3 apterae viviparae and 3 alatae viviparae ex. *Sonchus* sp., Nainital, 4.xii.79; 4 apterae viviparae and 4 nymphs ex. *Sonchus* sp., Ranikhet, 22.iii.80.

Liosomaphis berberidis (Kaltenbach): 6 apterae viviparae and 4 nymphs ex. *Berberis aristata,* Nainital, 13.iii.80; 4 apterae viviparae and 4 nymphs ex. *Berberis* sp., Almorah, 19.iii.80.

Macrosiphum aulacorthoides David, Narayanan and Rajasingh: 3 apterae viviparae ex. *Ocimum canum,* Nainital, 3.xii.79.

Macrosiphum euphorbiae (Thomas): 3 apterae viviparae ex. indet plant of Rosaceae, Almorah, 9.xii.79.

Metopolophium sonchifoliae Raychaudhuri, Ghosh and Das: 4 apterae viviparae and 1

nymph ex. *Rubus ellipticus*, Nainital, 4.xii.79.

Mollitrichosiphum buddlejae Ghosh, Banerjee and Raychaudhuri: 2 apterae viviparae and 1 nymph ex. *Alnus nepalensis*, Almorah, 17.iii.80.

Myzus cymballariellus Stroyan: 1 aptera vivipara and 1 nymph ex. *Sedum* sp., Almorah, 17.iii.80.

Pseudoastegopteryx himalayensis Ghosh, Pal and Raychaudhuri: 1 aptera vivipara and 1 nymph ex. indet. bamboo plant, Almorah, 17.iii.80.

Reticulaphis distylii rotifera Bille Ris Lambers and Takahashi: 2 apterae viviparae and 6 nymphs ex. *Quercus* sp., Nainital, 5.xii.79.

Rhopalosiphum nymphaeae (Linn.): 3 apterae viviparae, 1 alate vivipara and 1 nymph ex. an aquatic plant, Ranikhet, 8.xii.79.

Takecallis arundinariae (Essig): 2 alatae viviparae ex. *Bambusa* sp., Nainital, 4.xii.79.

Toxoptera odinae (van der Goot): 1 alate vivipara in yellow pan water trap, Almorah, 19.iii.80.

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23. NEW RECORD OF INSECT PESTS INFESTING KASTURI BHENDI, *HIBISCUS ABELOMOSCHUS* LINNAEUS, A MEDICINAL PLANT

Kasturi Bhendi, *Hibiscus abelomoschus* L. a useful medicinal plant has been reported to be attacked by the cotton shoot weevil, *Alcidodes affaber* Aurivillius (Coleoptera: Curculionidae) (Devaiah *et al.* 1981).

It was revealed in a survey made during August-September, 1980 at the Regional Research Station, University of Agricultural Sciences, Dharwad Campus, Karnataka that this plant is attacked by ten insect pests. These pests are being reported on this plant for the first time.

SPOTTED BOLLWORMS *Earias cupreovirides* Wlk. and *E. insulana* Boisd.

The adult moths laid eggs on the fruits and the young ones after emergence bore into the flower buds and pods of the plant. The percentage of incidence was 19.04. The caterpillars make irregular tunnels evident by the excreta thrown out and completely damage the seeds of the pod. The number of grubs in each pod varied from 1 to 3 with an average of 2. The fully grown caterpillars pupate either within the pod or outside in silken cocoons.

TOBACCO LEAF EATING CATERPILLAR *Spodoptera litura* F. feeds on the leaves also bores into the pods. The incidence of this pest is sporadic. The fully grown larvae pupate outside the pod.

GRAM CATERPILLAR *Heliothis armigera* Hb.

feeds on pods. The eggs were laid on the pods and young ones bore into the pods. The number of caterpillars in each pod varied from 1 to 2.

COTTON SEMI-LOOPER *Anomis flava* Fb. defoliates the plants by cutting the leaves. The incidence was sporadic.

RED COTTON BUG *Dysdercus cingulatus* Fb. Both nymphs and adults suck sap from the seeds of the ripening pod and renders the seeds unfit for further use. Average number of nymphs in an infested pod was 57. The infestation of this bug was found only when the pods were already infested by bollworms.

DUSKY COTTON BUG *Oxycarenus hyalinipennis* Costa. Both nymphs and adults of this bug suck the sap from the dried opened pods and rendered the seeds useless. The average number of nymphs in an infested pod was 83. Similar to red cotton bug, the infestation of dusky cotton bug was also found only after the pods were infested by bollworms.

MYLLOCERUS BEETLE *Myllocerus undecimpustulatus* var. *maculosus* Desbr. The adults feed on the leaves from the margins. The number on each leaf varied from 1.0 to 2.0 with an average of 1.0. The beetles prefer tender leaves for feeding.

CETONID BEETLE *Oxycetonia versicolor* F. Feed on the soft and tender pods.

BLISTER BEETLE *Mylabris pustulata* (Thunb.) feeds on the flowers.

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24. A NEW RECORD OF *NEOPHEOSIA FASCIATA* (MOORE) ON APPLE

Neopheosia fasciata (Moore) (Notodontidae: Lepidoptera) was recorded for the first time, on apple at Regional Fruit Research Station, Mashobra, Simla during 1978-79. Caterpillars found feeding on apple foliage were reared and further studies were carried out in the laboratory.

Larva is pale green; head streaked with red lines; thoracic segments and legs green and abdomen brown dorsally and light green ventrally with a prominent brown process on dorsal side of the first abdominal segment. Larva becames full grown in 22-28 days and measures 3.8 to 4.0 cm. It defoliates apple during May-early June and during late July-August. Pupation occurs in loose silken threads on leaves in June and it lasts for 25-27 days. Larva of the second generation pupates during September-early October in debris or in crevices of the bark where it over-winters. Moth emerges after 230-270 days, in May, next year.

Adult is brown; fore wings pale brown with dark brown streaks on and below the costa, a series of short streaks on and towards the

outer margin, inner margin dark brown; hind wings light brown, outer margin brown and anal angle dark brown. Antennae are slightly bipectinate. Male moth is smaller (4.2 cm) than the female moth (4.5 cm) when measured with wings expanded. It is active during May and again in July. Eggs laid singly by a female moth without mating, are creamish yellow and round.

N. fasciata was reported to occur in India by Hampson (1892) as *Pheosia fasciata* Moore. After this record the insect does not seem to have been reported from any where in India or elsewhere. The present account is, therefore, the new record of *N. fasciata* on apple.

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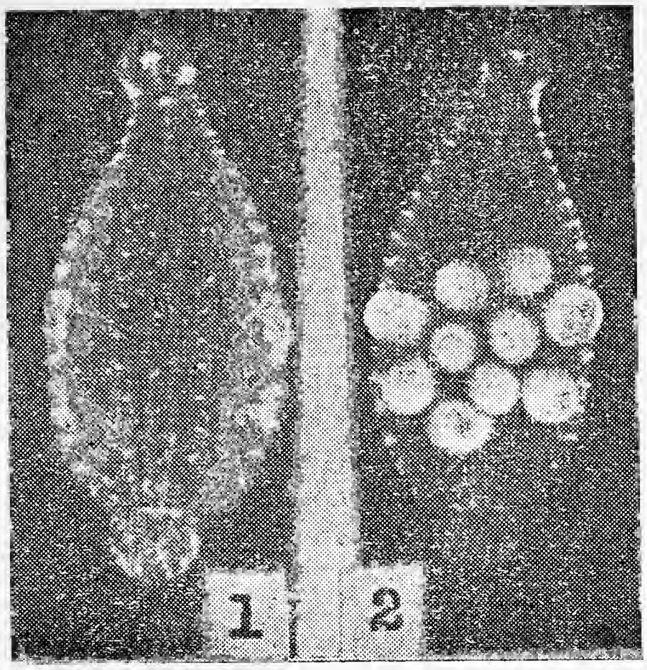
HAMPSON, G. F. (1892): Fauna of British India including Ceylon & Burma, Moths. Vol. I, p. 160. London, Taylor & Francis.

25. ON A GLOSSIPHONID LEECH

(*With three text-figures*)

Among fresh water Hirudineans Glossiphonid leeches are small invertebrates that prey largely on water snails (Clegg 1952). These leeches do not form true cocoons but carry their fertilized eggs in membranous capsules on the ventral surface of the body. After hatching the young remain on the body of the parent in the same area, attached to the parent by means of mucous threads. Young ones probably feed on mucus, until they reach a certain size and then detach themselves from the parent to lead a free life (Pennak 1953). I came across a similar glossiphonid leech, which is quite often found inside or attached to the shell of a freshwater bivalve *Lamellidens corrianus* from river Mula, Poona. The leech appears to be *Hemiclepsis marginata* as per the descriptions of Harding and Moore (1927). The photographs show dorsal surface of an individual with characteristic rows of yellow spots (Fig. 1) and ventral surface of the same individual with 10 large, prominent eggs attached to the body (Fig. 2). Such leeches with eggs were often found to be resting at one place for a long time with only undulating body movements. In two observed cases after about 11-13 days the small leeches came out of the eggs. The young ones were observed to come out from under the parent leech and, if disturbed, to retreat to the same shelter (Fig. 3). The parent leech guarded its young ones in a similar manner as it guarded



Hemiclepsis marginata
Fig. 1. Dorsal surface with characteristic rows of yellow spots.
Fig. 2. Ventral surface with 10 large eggs attached to the body.

Fig. 3. Young ones were observed to come out from under the parent leech.

the eggs — a kind of parental care. I am not aware whether the glossiphonid mentioned here is a known parasite of the *Lamellidens* or some other animal. It is mentioned, however, in Fauna of British India that some specimens were found in *Lamellidens.*

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26. STUDIES ON THE BIOLOGICAL CONTROL OF TWO COMMON VECTOR SNAILS OF PUNJAB BY PREDATORY INSECTS

8 species of aquatic insects have been screened for their predatory activity against two species of snails viz. *Limnoea luteola* and *Indoplanorbis exustus*. Larvae of *Hydaticus* sp. are the most efficient predators of *L. luteola* as they consumed 84.3% of the snails exposed to them and the other species in decreasing order ranked as follows, *Laccotrephes ruber* (70%), *Diplonychus rusticum* (43.3%), *Laccotrephes griseus* (40%) and *Lethocerus indicus* (22.2%). *Laccotrephes ruber* is the most efficient predator of *I. exustus* as it consumed 84.3% of the snails and the other species in decreasing order ranked as follows, *Diplonychus rusticum* (60%), *Hydaticus* sp. larvae (52.5%), *Lethocerus indicus* (20%), *Cybister* sp. (18.7%) and *Laccotrephes griseus* (16.6%). *Ranatra elongata* and *Strenolophus* sp. did not feed either on *L. luteola* or on *I. exustus* and *Cybister* sp. did not feed on *L. luteola.*

Introduction

The importance of snails cannot be over emphasised as many of them act as the intermediate hosts of several important diseases of man and livestock namely Schistosomiasis, Fascioliasis and Paramphistomiasis and some are serious crop and garden pests. Their control is, therefore, rather essential. Controlling snails through chemical methods involves large scale dissemination of pesticides or molluscicides which in addition to being expensive may prove hazardous to the health of livestock and man. Studies for the development of alternate methods of snail control are, therefore, quite necessary. The need to develop new methods for the control of medically important snails has also been stressed by the U.S. Parasitic Diseases Panel (Anonymous 1971).

Bequaert (1925, 1926) studied the arthropod enemies of molluscs with particular emphasis on the dipterous parasites of snails. Berg (1953, 1961, 1964a, 1964b, 1973) studied the potential of sciomyzid fly larvae for snail-killing and highlighted their importance for the biological control of snails. The role of sciomyzid fly larvae for the biological control of snails was also stressed by Neff (1964), Neff & Berg (1966), Knutson *et al.* (1967, 1970), Bratt *et al.* (1969), Eckblad (1971), Ferguson *et al.* (1971) and Geckler (1971). The biological control of snails through giant water bug was studied by Somasunderarao (1963), through another belostomatid bug by Voelker (1968) and through *Hydrophilus* beetles by Maillard (1971). Studies on the biological control of snails as such have also been carried out by Chernin *et al.* (1956, 1971) Michelson (1957), Ferguson *et al.* (1956, 1971), Petitjean (1966), Scott (1970), Yasuvaoka (1970) and Muley (1978).

It was, therefore, considered worthwhile to find out the biological control agents from amongst the aquatic insects living in the water bodies inhabited by snails. The present study deals with the assessment of 8 species of aquatic insects for the biological control of two important species of vector snails namely *Indoplanorbis exustus* and *Limnoea luteola.*

Materials and Methods

Eight species of aquatic insects namely *Laccotrephes ruber* Linn., *L. griseus* Guer. and *Ranatra elongata* Fabr. belonging to Nepidae

(Hemiptera); *Diplonychus rusticum* (Fabr.) and *Lethocerus indicus* (Lep. and Serv.) belonging to Belostomatidae (Hemiptera); *Cybister* sp. and *Hydaticus* sp. larvae belonging to Dytiscidae (Coleoptera); and *Sternolophus* sp. belonging to Hydrophilidae (Coleoptera) were used in the experiments and these were collected from the different permanent water bodies of Ludhiana district. Two species of laboratory bred snails i.e. *Indoplanorbis exustus* and *Limnoea luteola* in well established aquaria were exposed to the attack of the above aquatic insects and their rates of snail consumption were recorded. Their interesting behaviour patterns were also photographed. The observations were made over a period of about two weeks.

Results and Discussion

Out of the 8 species of predacious insects used in the present study the larvae of *Hydaticus* sp. ranked first for the control of *Limnoea*

TABLE 1

SHOWING THE CONSUMPTION RATE OF *Limnoea luteola* AND *Indoplanorbis exustus* BY AQUATIC INSECTS ..

Sr. No.	Name of insect	Snail species	No. of snails used	No. of snails left unconsumed	Soft mass/ shell consumed	Consumption %
1	2	3	4	5	6	7
1.	*Laccotrephes griseus* Guer.	*Limnoea luteola*	20	12(8)	Only soft mass consumed	40
		Indoplanorbis exustus	18	15(3)		16.6
2.	*L. ruber* Linn.	*L. luteola*	30	9(21)	—do—	70
		I. exustus	32	5(27)		84.3
3.	*Ranatra elongata* Fabr.	*L. luteola*	6	6(0)	—do—	0
		I. exustus	8	5(3)*		
4.	*Diplonychus rusticum* (Fabr.)	*L. luteola*	30	17(13)	—do—	43.3
		I. exustus	30	12(18)		60
5.	*Lethocerus indicus* (Lep. & Serv.)	*L. luteola*	9	7(2)	—do—	22.2
		I. exustus	20	16(4)		20
6.	*Cybister* sp.	*L. luteola*	15	15(0)	—do—	0
		I. exustus	16	12(3)		18.7
7.	*Sternolophus* sp.	*L. luteola*	20	20(0)	—do—	0
		I. exustus	22	20(2)*		0.09
8.	*Hydaticus* sp. larvae	*L. luteola*	70	11(59)	17 shells completely eaten and 50% shells of the rest partly eaten	84.3
		I. exustus	40	19(21)		52.5

N.B. Figures in parenthesis under heading 5 indicate snails consumed.
* Natural death.

luteola as they ate up 84.3% of the snails exposed to their predatory activity. They were found to be voracious feeders of snails as they even ate up the hard shells along with the soft parts. The other species which ranked next in decreasing order were *Laccotrephes ruber, Diplonychus rusticum, Laccotrephes griseus* and *Lethocerus indicus* as they consumed 70%, 43.3%, 40% and 22.2% of the *L. luteola* snails respectively (Table 1). The other 3 species namely *Ranatra elongata, Cybister* sp. and *Sternolophus* sp. did not feed even on a single *L. luteola* snail. *Laccotrephes ruber* has been found to be the most efficient predator of *Indoplanorbis exustus* as it consumed 84.3% of the snails exposed to its predatory activity. The other species namely *Diplonychus rusticum, Hydaticus* sp. larvae, *Lethocerus indicus, Cybister* sp. and *Laccotrephes griseus* consumed 60%, 52.5%, 20%, 18.7% and 16.6% of the *I. exustus* snails respectively. *Ranatra elongata* and *Strenolophus* sp. did not consume any *I. exustus* snail although 3 out of 8 snails & 2 out of 22 snails exposed to them respectively died a natural death. Somasundararao (1963) also studied the predatory activity of *Sphaerodema rusticum* (now called as *Diplonychus rusticum*) and found that 39 bugs destroyed 309 snails in 5 days which worked out to be 45 snails per month for each bug. He further observed that *Limnoea luteola* snails were preferred over *Indoplanorbis corneus* and the latter over *Limnoea accuminata.*

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27. NECROPHAGOUS HABIT IN THE GIANT AFRICAN SNAIL, *ACHATINA FULICA FULICA* BOWDICK

(*With a plate*)

On the sunny day of 18th August, 1982 at 6.45 A.M. one of us (RMS) saw a house lizard, *Hemidactylus frenatus* Schlegel dying in a cemented open space near the bath room of his house. The lizard was lying upside down. In the vicinity a number of giant African snails, *Achatina fulica fulica* Bowdick were also present. Out of them one snail came towards the lizard, crawled on it from the head end, came upto the lower jaw and started devouring it within a couple of minutes. Initially the lizard moved its limbs but after 15 minutes it became motionless. This feeding was continued upto 8.10 A.M. When the snail retired, skin and flesh of the lower jaw and the neck of the lizard were found to be eaten

away. A peculiar *chuck-chuck* sound was heard all the time during the feeding.

In order to confirm this habit of *Achatina fulica* an experiment was conducted. On 26th August, 1982 at 8.15 A.M. the same species of house lizard was collected, made almost motionless and kept upside down in the same place where the earlier incident occurred. Then two giant African snails were brought and placed near the lizard. Both the snails came to the lizard which was then alive and moving its limbs slowly. Both the snails crawled on the lizard. But one showed no attraction for it and ultimately went away, while the other started eating its skin and flesh of the abdomen region. The lizard was still alive and showed some movements but the snail did not let loose. The lizard completely stopped its movement at 8.35 A.M. Feeding continued upto 9.30 A.M. and the same *chuck-chuck* sound was heard. During the feeding this time the snail turned the lizard's body to the lateral side and went on nibbling at its skin and muscle till it could finish up the portion from the abdomen to the head region.

The giant African snail has the status of a serious international pest of a number of important crops and herbivorous habit of this snail is very well known. There is no record on the flesh eating habit of this snail barring a single report by Mead (1961) who observed *Achatina fulica* to feed on a dead black rat in Guam Island (in South America). A perusal of literature also shows that pulmonates in general are herbivorous but they devour dead and decomposed flesh when easily available (Hyman 1967, Mitra and Biswas 1974, Raut and Ghose 1982).

Although in the present case *Achatina fulica* fed on the flesh of dying lizard not the dead or decomposed one still this is the same necrophagous habit as stated earlier. Because this feeding habit of *Achatina* is quite different from that of carnivorous pulmonates which hunt animal prey (Watson 1915, Hyman 1967).

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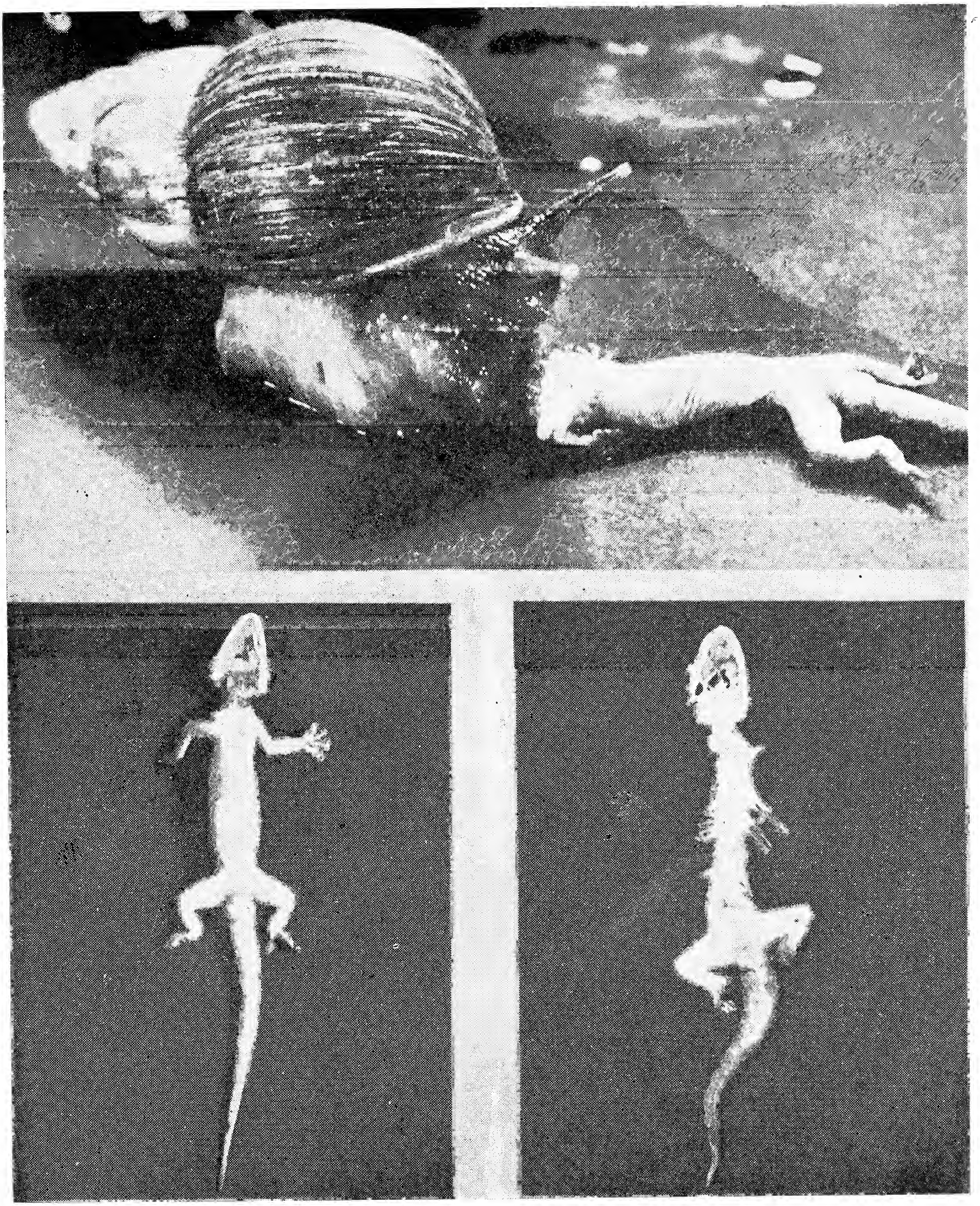

Above: *Achatina fulica fulica* feeding on a house lizard, *Hemidactylus frenatus*.
Below: (Left) — *H. frenatus* after being eaten by *A. fulica fulica*.
(Right) — *H. frenatus* after being eaten by *A. fulica fulica* in the second case.

28. A CONTRIBUTION TO THE VEGETATION OF CHAIBASA (NORTH), SINGHBHUM DIST. (NORTH BIHAR)

91 more plants under 84 genera collected from Chaibasa (North) forest have been accounted for in this paper. Of these 11 species are monocotyledons and 80 species are dicotyledons. 81 species under 71 genera collected from Chaibasa (South) forest are published in earlier works [*J. Bombay nat. Hist. Soc.* 77(2): 223-226].

Enumeration

In the following enumeration the system of Bentham and Hooker with some delimitations has been followed. Nomenclature has been as far as possible brought up to date. It may be noted that the following species were collected during the months of June-July 1980. The field numbers mentioned against the place of collections is indicative of the author's own contribution. The enumerated taxa have been deposited at N.B.S. Mahavidyalaya, Bishnupur, Bankura (West Bengal).

DICOTYLEDONS

Ranunculaceae

Clematis gouriana Roxb. ex Dc. Biswas 10
Thalictrum javanicum Bl. Biswas 22

Magnoliaceae

Michelia champaca L. Biswas 23

Anonaceae

Desmos chinensis Lour. Biswas 44
Polyalthia longifolia (Sonn.) Thw. Biswas 50
P. cerasoides (Roxb.) Bth. & Hk. f. Biswas 61

Nymphaeaceae

Nelumbo nucifera Gaertn. *Nelumbium speciosum* Willd. Biswas 72
Nymphaea nouchali Burm. f.
N. pubescens Willd. Biswas 82

Papaveraceae

Papaver somniferum L. Biswas 32

Cruciferae

Brassica juncea (L.) Czern.
B. nigra Koch Biswas 2
Coronopus didymus (L.) Sm.
Lepidium didymum L. Biswas 25
Raphanus sativus L. Biswas 34

Capparaceae

Cleome viscosa L. Biswas 39

Bombacaceae

Bombax ceiba L.
B. malabaricum DC. Biswas 15

Malvaceae

Pavonia odorata Willd. Biswas 52
Sida cordifolia L. Biswas 73
S. acuta Burm. f. Biswas 67

Sterculiaceae

Melochia corchorifolia L. Biswas 70
Pterospermum acerifolium Willd. Biswas 55

Tiliaceae

Corchorus aestuans L.
C. acutangulus Lamk. Biswas 1

RUTACEAE

Aegle marmelos (L.) Corr. Biswas 7
Limonia acidissima L.
Feronia elephantum Corr. Biswas 12

MELIACEAE

Azadirachta indica A. Juss.
Melia azadirachta L. Biswas 62
Chloroxylon swietenia DC. Biswas 3
Swietenia mahogani Jacq. Biswas 13

RHAMNACEAE

Zizyphus oenoplia (L.) Mill Biswas 53

VITACEAE

Cayratia pedata (Lamk.) Juss. ex Gagnep. *Cissus pedata* Lamk. Biswas 85
Cissus quadrangula L.
C. setosa Roxb. Biswas 29

SAPINDACEAE

Cardiospermum halicacabum L. Biswas 26

ANACORDIACEAE

Buchanania lanzan Spreng. Biswas 11

PAPILIONACEAE

Abrus precatorius L. Biswas 9
Clitoria ternatea L. Biswas 14
Crotalaria juncea L. Biswas 8
Desmodium motorium (Houtt.) Merr. *D. gyrans* (L. f.) DC. Biswas 4
Erythrina variegata L.
E. indica Lamk. Biswas 56
Tephrosia purpurea (L.) pers. Biswas 60

CAESALPINIACEAE

Cassia occidentalis L. Biswas 31
Caesalpinia pulcherrima (L.) SW. Biswas 58
Peltophorum pterocarpum (DC.) Baker ex. K. Heyne
P. ferrugineum Benth. Biswas 5
Saraca asoca (Roxb.) De Wilde Biswas 6

MIMOSACEAE

Acacia nilotica (L.) Willd. ex Del. Subsp. *indica* (Benth.) Brenm. Biswas 18
A. auriculiformis A. Cunn. Biswas 42
Mimosa pudica L. Biswas 63
Pithecellobium dulce (Roxb.) Benth. Biswas 16

ONAGRACEAE

Centella asiatica (L.) Urban.
Hydrocotyle asiatica L. Biswas 19
Ludwigia prostrata Roxb. Biswas 35
L. perennis L. Biswas 17
Oenanthe javanica (Bl.) DC.
O. benghalensis Benth. and Hk. f. Biswas 30

RUBIACEAE

Borreria articularis (L.f.) Williams
Spermacoce hispida L. Biswas 38
Ixora arborea Roxb. ex Smith
I. parviflora Vahl Biswas 33
I. coccinea L. Biswas 83
Pavetta indica L. Biswas 20

COMPOSITAE

Blumea lacera (Burm. f.) DC. Biswas 21
Tridax procumbens L. Biswas 36

OLEACEAE

Jasminum arborescens Roxb. Biswas 37

APOCYNACEAE

Nerium indicum Mill. Biswas 27
Rauvolfia serpentina (L.) Benth. ex Kurz Biswas 64

ASCLEPIADACEAE

Calotropis procera (Willd.) Dryand ex W. Ait. — Biswas 28
Pergularia daemia (Forsk.) Choiv. *Daemia extensa* R. Br. — Biswas 54

GENTIANACEAE

Canscora diffusa (Vahl.) R. Br. ex Roem and Schult. — Biswas 59

BORAGINACEAE

Cordia dichotoma Forst. f. — Biswas 68
Heliotropium indicum L. — Biswas 40
H. ovalifolium Forsk. — Biswas 86

CONVOLVULACEAE

Cuscuta reflexa. Roxb. — Biswas 71
Ipomea aquatica Forsk. *Ipomea reptens* poir — Biswas 74

SCROPHULARIACEAE

Lindernia ciliata (Colsm.) Pennell. *Bonnaya brachiata* Link. Otto — Biswas 75
Limnophila heterophylla (Roxb.) Benth. — Biswas 89

ACANTHACEAE

Barleria prionitis L. — Biswas 90
Hygrophila auriculata (Schum.) Heine — Biswas 77
Rungia pectinata (L.) Nees *R. parviflora* (Retz.) Nees var. *pectinata* (L.) Cl. — Biswas 91

VERBENACEAE

Clerodendrum viscosum vent. *C. infortunatum* auct pl. (non L.) — Biswas 78
Tectona grandis L. f. — Biswas 43

LABIATAE

Hyptis suaveolens (L.) Poit. — Biswas 45

AMARANTHACEAE

Amaranthus spinosus L. — Biswas 47
A. viridis L. — Biswas 49

EUPHORBIACEAE

Acalypha indica L. — Biswas 51
Antidesma ghesmbilla Gaertn. — Biswas 81
Croton bonplandianum Baill *C. sparsiflorum* Morang — Biswas 76
Jatropha gossypifolia L. — Biswas 53
Phyllanthus fraternus webster *P. niruri* Hook. f. — Biswas 54

MONOCOTYLEDONS

HYDROCHARITACEAE

Hydrilla verticillata (L. f.) Royle — Biswas 87

ORCHIDACEAE

Vanda tessellata (Roxb.) Hk. ex G. Don *V. roxburghii* R. Br. — Biswas 57

AMARYLLIDACEAE

Curculigo orchioides Gaertn. — Biswas 65

COMMELINACEAE

Amischophacelus axilloris (L.) Rolla Rao and Kamm. *Cyanotis axillaris* (L.) Roem and Schult. — Biswas 69
Commelina appendiculata Cl. — Biswas 41
C. benghalensis L. — Biswas 66

CYPERACEAE

Fimbristylis spathacea Roth — Biswas 24

POACEAE

Arundinella setosa Trin. Biswas 80
Chrysopogon aciculatus (Retz.) Trin.
Andropogon aciculatus Retz. Biswas 88
Eragrostis coarctata Stapf Biswas 46
Sclerostachya fusca (Roxb.) A. Camus Biswas 48

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29. OCCURRENCE OF *DESMODIUM SCORPIURUS* (SWARTZ) DESVAUX IN WESTERN INDIA

(*With five text-figures*)

During routine plant collection around Pune, an unusual plant of *Desmodium* type was noticed. It showed quite different morphological features and we could not match it with any species of Papilionaceae occurring in Maharashtra. It grows near hedges among grasses and low shrubs. It thrives well in coarse soils. So far a single patch of this species has been observed in the Pune Municipal area. The plant has been identified as *Desmodium scorpiurus* (Sw.) Desv. and described as follows:

Desmodium scorpiurus (Sw.) Desv. Journ. Bot. 1: 122, 1813; DC. Prodr. 2: 333, 1825; Schubert, Fl. Peru, 8: 433, 1943; *Hedysarum scorpiurus* Sw. Prodr.: 107, 1788; *Meibomia scorpiurus* (Sw.) O. Ktze. Rev. Gen. 1: 198, 1891; *Nissoloides cylindrica* M. E. Jones, Contr. West. Bot. 18: 135, 1935 (Figs. 1 to 5). Scorpiurus, refers to the monoliform hairy pods showing much resemblance with the tail unit of the scorpion.

A diffuse straggling herb. Stem wiry, somewhat angled, grooved, ascending, covered with hooked hairs. Leaves trifoliate, alternate, glabrescent to puberulous; stipule foliaceous, 3-5 mm long, ovate, acuminate, amplexicaul-auriculate at base; leaf rachis 3-7 cm long; petioles ± 1 mm; stipules filiform, ± 1 mm long; lateral leaflets 3-7 cm by 1.5-4.0 cm, ovate-oblong, or elliptic-oblong, obtuse; terminal leaflets 2.0-6.0 cm by 1.5-4.5 cm, elliptic or obovate, obtuse; main nerves 5-7 pairs; conspicuous beneath; leaflets sparsely hairy on both surfaces, more dense beneath with a few hooked hairs. Flowers in terminal and axillary racemes of 15-20 cm length, laxly arranged in few flowered (2-4) fascicles; pedicels filiform, 3-6 mm long, puberulous; bracts 2-3 mm long, persistent, lanceolate, acute, ciliate; calyx 2 mm long, hairy; teeth about as long as the tube, linear, acute, ciliate; corolla 3-4 mm long, standard white, wing purplish or white diffused with violet, ultimately fading to lemon-yellow;

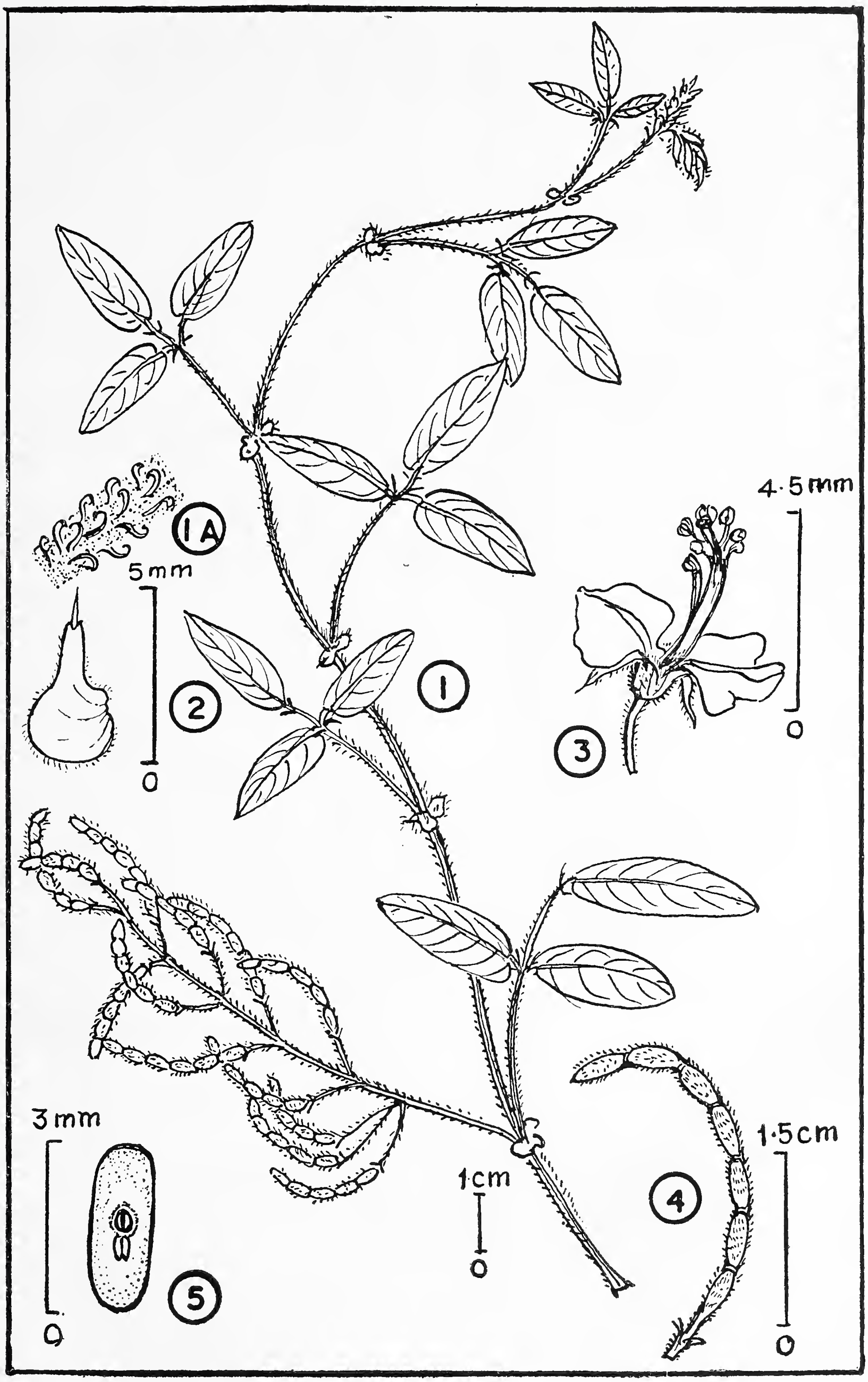

Fig. 1-5. *Desmodium scorpiurus* (Swartz) Desvaux.
1. Habit; 1A. Pubescence on the stem (enlarged); 2. Stipule; 3. Flower; 4. Pod; 5. Seed.

stamens 10 (9 + 1), vexillary one entirely free, the other nine united, anthers uniform; ovary shortly stalked, ovules 6-8; style incurved; stigma terminal, minute, capitate. Pods linear, monoliform, 4-6 cm long, joints 6-8, 3.0-4.0 by 1.0 mm, flat with hooked hairs. Seeds ± 3 mm by 1 mm, rhomboidal, lemon — yellow to pale brown, smooth.

Flowers: October-February.

Fruits: November-March.

Field notes: A very distinct species with small flowers and narrow, long, straight or slightly falcate moniliform pods covered with hooked hairs. Segments are easily breakable and they adhere to the bodies of browsing animals and even to clothes of field collectors. Found on heavy clay soils in open low lands exposed to severe dry season. Occurs near Mutha river side near Dattawadi, Pune on waste lands and was collected from October 1981 to February 1982. It has also been reported in the Aarey Colony area of Bombay by Dr. Y. S. Kulkarni. Voucher specimens are deposited in (1) Herbarium of Maharashtra Association for the Cultivation of Science, Pune and (2) Central National Herbarium, B.S.I., Calcutta.

The plant is not mentioned in Cooke's flora and efforts to identify by this Flora failed. However, it may come closer to *Desmodium laxiflorum* DC. and D. *dichotomum* (Willd.) DC. from which it differs in the following respects: 1) twining, straggling herb, 2) Size and shape of the leaves, 3) nature of pubescence, 4) colour of flowers fading to lemon-yellow, 5) rhomboidal seeds. It also varies to some extent from the *D. scorpiurus* species of Peru (Schubert 1943) in 1) dimensions of leaf rachis and leaflets, 2) size and monoliform nature of pods.

Localities: Mutha river side, near Dattawadi, Poona-common, *Vartak* 25714-16; Govt. pastures, Aarey colony, near Bombay, very common, *Kulkarni* 26001-3.

The specimens were confirmed by the authorities of Central National Herbarium, Calcutta. It is a native of Mexico, Central America, West Indies and South America, south to Peru. It occurs very commonly in the Pacific Asia and Africa as an introduced and naturalized weed. It's occurrence in Western India, however, has been located for the first time and hence reported in the present note.

Thanks are due to Dr. K. Thothathri and Dr. A. Pramanik of Central National Herbarium, Calcutta for confirmation, to Prof. K. R. Surange, Director, MACS, for laboratory facilities, and to Shri V. C. Deo for drawing.

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Reference

Schubert, B. G. (1943): Flora of Peru. Vol. 8, Port III, No. 1: 413-439. Botanical Series, Field Museum of Natural History, Chicago.

30. IDENTIFICATION AND DISTRIBUTIONAL NOTE OF A FEW SPECIES OF *EPILOBIUM* LINN. IN INDIA

The paper presents the distributional record of two newly described species namely *E. gouldii* & *E. squamosum* and extension of distribution of *E. cylindricum*

The genus *Epilobium* Linn. with more than 200 species occurs in all continents relatively at high altitudes. Clarke (1879) described 12 species under the genus *Epilobium* from East and North-East Himalaya. Raven (1962) recognised 37 species which include 13 new taxa from the Himalayan region and recorded 31 taxa from India.

During identification and study of the Indian *Epilobium* in herb. CAL we came across some interesting specimens. Further critical study with the available literature, type specimens and the photographs from Kew herbarium reveal that they belong to two newly described species of *Epilobium* described by Raven (1962).

The specimens, one collected from Gurhwal and the other from Mussourie have been identified as *E. squamosum* Raven. The species was so far known from Nepal, eastward to Bhutan and Western Yunnan. So it is here reported for the first time from India showing a westward extension of distribution of the taxon. Another specimen collected from Kashmir has been identified as *E. gouldii* Raven, so far reported from South East Tibet and Sikkim. The new report of this taxon thus establishes its westward extension. *E. cylindricum* DC., a species well distributed in sino-himalayan area is reported here for the first time from Arunachal Pradesh. A short description is provided below for easy identification.

Epilobium gouldii Raven in Bull. Brit. Mus. 2(12): 371 et pl. 35B. 1962.

Perennial herbs 20-25 cm tall, partly subterranean, underground parts often with scales, broadly ovate dead leaves at the base; plants not pubescent throughout; internodes small, prominent pubescent lines decurrent from the base of the leaves. Leaves opposite, often alternate towards apex, sessile (10-) 18-22 (–25) x (4-) 6-8 (–10) mm, ovate, apex acuminate, base subrounded, margin serrulate, glabrous or sparsely pilose on the nerves, subcoriaceous. Inflorescence axillary or terminal, nodding at anthesis, subtending bracts smaller than the ovary. Flowers 6-7 mm long. Sepals 5, 3.5-4.0 mm long, ovate-acuminate, pubescent dorsally. Petals 5, rose purple, obcordate, 4.5-6.0 mm long. Stamens 5, filaments short, anthers cordate, remains near the stigma. Ovary densely pubescent, strigose. Style 2.5-3.0 mm long, stigma clavate-capitate. Capsule 5-6 cm long. Seeds less than 1 mm long, obovoid, papillose, verrucose.

Type: Gautsa to Phari, 12,000-14,300 ft (3650-4350 m), 13 Aug. 1938, *Gould* 1452 (K; photograph CAL).

Distribution: INDIA: Kashmir, (Sikkim), TIBET.

Specimens examined: TIBET: without precise locality, 1882, *Dr. King's Collector* 146 (CAL). INDIA: Kashmir, Astor Dist., Gudhai valley, 3344-3648 m, 12.7.82, *J. F. Duthie* 12198 (CAL).

From this disjunct distribution it is presumed that this taxon may be available in Kumaon Himalaya and Nepal.

Epilobium squamosum Raven in Bull. Brit. Mus. 2(12): 380. et pl. 39B. 1962.

Perennial herbs 8-10 cm tall, unbranched,

upper part pubescent, lower part glabrous but prominent line of hairs decurrent from the petiole, internodes small, underground stem with a series of small imbricate coriaceous scales. Leaves opposite, sessile or subsessile, broadly ovate, (10-) 12-15 (-18) x (6-) 8-10 (-15) mm, apex acute, base subrounded or subcordate, margin obscurely serrulate, sparsely hairy on the nerves, membranous or subcoriaceous. Inflorescence mostly terminal, nodding after anthesis, subtending bracts foliaceous, usually $\frac{1}{2}$ the ovary. Flowers 7-10 mm long. Sepals 5.0-6.0 × 1.5-2.0 mm, apex acute or apiculate, dorsally pubescent. Petals rose purple, 6-9 mm long, obcordate. Stamens smaller than the style. Ovary distinctly curved, sparsely pubescent, style 4-5 mm long, stigma capitate. Capsules 2-4 cm long, curved, glabrous or sparsely pubescent.

Type: Chhoyang khola, west of Num, Arun valley, 3500 m, 20 June 1956, *D. A. Stainton* 726 (BM).

Distribution: INDIA, NEPAL.

Specimens examined: Uttar Pradesh, Gurhwal, 1869, Sine coll. *s.n.;* Near Mussourie, N. W. Himalaya 1869, *G. King s.n.* (CAL).

The species is related to *E. sikkimense* in having leaves broadly ovate with obscurely serrulate margin and smaller habit, in addition to distinct curved ovaries as noted by Raven.

E. cylindricum D. Don, Prodr. Fl. Nep. 222. 1825. — Hausskn. Monogr. Epil. 200. 1884. — Raven in Bull. Brit. Mus. 2(12): 355. 1962 — *E. roseum* var. *cylindricum* (D. Don) Clarke in Hook. f., Fl. Brit. Ind. 2: 585. 1879.

Type: NEPAL: Sheopuri Hill, North of Kathmandu, Aug. 1821, *Wallich* num. list No. 6328 (BM, lectotype; E; G; K; W and CAL).

Distribution: North eastern Afghanistan to the Tian Shan range and throughout the Himalaya to Szechwan, Yunnan and Hupeh. In India the species is well distributed in the Sino-himalayan range and is reported to occur in Jammu & Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal and also in S.E. Tibet, Nepal, Sikkim and Bhutan.

The specimens cited below from Arunachal Pradesh thus confirm its new eastward extension of occurrence.

Specimens examined: Kameng District, Bomdila camp on the way to Dirong Dsong, on the hill top, 13.4.1957, *G. Panigrahi* 6870 (ASSAM, CAL)! Rupa-gegaon, 1570-1329 m, 9.4.1957, *G. Panigrahi* 6699 (ASSAM, CAL)!; Bomdila, 6 km towards the Terpa valley, along the roadside near the drain, 2500 m, 14 Sept. 1964, *J. Joseph* 39916 (ASSAM, CAL)!; Lohit F. D., Dreyi — Shoeliang 1200-625 m, 13.11. 1957, *Rolla Seshagiri Rao* 10505, 10545 (ASSAM, CAL)!

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31. *CUCUMIS MELO* LINN. IN PUNJAB — A TAXONOMIC REAPPRAISAL

In this paper a key and pertinent synonymy are provided for separation of various infraspecific taxa of *Cucumis melo* Linn. available in Punjab. Besides, the correct nomenclature of snake or serpent melon is also indicated.

Introduction

Cucumis melo Linn. with polymorphous fruits is often cultivated throughout the plains of India, chiefly on the sandy beds or margins of rivers, for the sake of its fruits. The fruits are edible and used unripe and ripe as salad, vegetable and table fruits besides being an important ingredient of an extensively sold seasonal spicy preparation locally called in north-west India as 'Chat'. This species has received divergent treatments in Indian taxonomic literature. The fruits being very large and fleshy are not preserved on the herbarium sheets except sometimes in very young stages. This, probably, has resulted in the varied circumscription of different taxa included under *Cucumis melo.* An attempt has been made here to clear the taxonomy of various constituents of this species as found in Punjab. The conclusions are based mainly on the field observations of various forms supplemented by the study of herbarium material.

Observations in literature

The taxon *C. melo* has received divergent treatments taxonomically. As indicated clearly by notes, local names and synonymy; Haines (1961), Prain (1963) and Tutin (in Tutin *et al.* 1968) treat *C. melo* as a Compositae taxon including several varieties distinguished by other taxonomists. Chakravarty (1959), while retaining var. *agrestis* includes all other varieties under var. *culta.* Somewhat similar view has been followed by Babu (1977) but with the difference that instead of var. *culta* he recognized var. *melo* with 5-100 cm long fruits and embracing all other varieties except var. *agrestis* which is kept distinct. Rau (1969) considers var. *melo* and var. *agrestis* as distinct and merges the other forms under var. *culta.* Sharma & Bir (1978) have kept var. *melo* separate from other forms which are put together under var. *culta.* Babu (1977) supports Gamble's (1957) treatment of considering *C. melo* var. *agrestis* as a distinct species under the name *C. pubescens* Willd. Duthie (1960) also treated *C. melo* var. *agrestis* as *C. pubescens* and retained other varieties under *C. melo.*

Present observations and conclusions

An extensive and intensive field study of various types in Punjab during the last two decades has shown that the different taxa discussed here under *Cucumis melo* Linn. are annuals with yellow flowers. These are either cultivated or are found as self sown or sometimes may become escape. Only one type (var. *agrestis*) is truly feral. The fruits are commonly sold in the local markets and the wild form is plentiful in waste places and fallow and agricultural fields. In all, four distinct varieties are easily recognizable. All of these should be treated as distinct and not merged under var. *melo* or var. *culta* as has earlier been done by different authors.

A perusal of taxonomic literature has shown

that no clear cut 'key' has been provided for the discrimination of these taxa. Presumably this is due to the different alignment of various forms under different names or because some authors consider all forms constituting a single taxon. Hence to fill in this lacuna; a 'key', base on discernible macroscopic features, is given below for the convenient segregation of the four varieties found in Punjab:

1. Plant slender, truly wild; leaves 2.5-9 cm across; corolla 0.5-1 cm long; fruits 2.5-3.5 cm long . . . . var. *agrestis*
1. Plants robust, cultivated, occasionally escape but never truly wild; leaves larger, corolla 1-1.5 cm long; fruits 5-100 cm long
    2. Ripe fruits bursting spontaneously......... .... var. *momordica*
    2. Ripe fruit otherwise (i.e. not bursting)
        3. Fruit at the most about $1\frac{1}{2}$ times longer than broad, without corduroy-like ridges .... var. *melo*
        3. Fruits normally several times longer than broad, with corduroy-like ridges.. .... var. *flexuosus*

Nomenclatural citations and pertinent literature and synonymy with special reference to the important Indian floristic works of these varieties along with some noteworthy annotations are as follows:

C. melo Linn. var. **agrestis** Naud. Ann. Sci. Nat. Par. ser. 4.II.73. 1859; ibid. 12: 110. 1859; Chakravarty, Rec. bot. Surv. Ind. 17 (1): 103. 1959; Sant. ibid. ed. 3. 16(1): 103. 1967; Babu, Herb. Fl. Dehra Dun 195. 1977. *C. pubescens* Willd. Sp. Pl. 4: 614. 1805; Gamble, Fl. Pres. Madras 1: 378. 1957, repr. ed.; Duthie, Fl. Upp. Gang. Pl. 1: 341. 1960, repr. ed.

Chakravarty (loc. cit.) distinguishes var. *agrestis* from var. *culta* Royle, *inter alia,* in the fact that the fruits are inedible in the former and edible in latter. However, the native people of Punjab not only eat the immature and mature fruits but also appreciate them with apparent relish. I have myself tasted the fruits on several occasions during the course of botanizing and found these very juicy. In the absence of water, the fruits are indeed refreshing for a thirsty person in the field. Occasionally, however, the fruits are bitter. After the rainy season, the fruits can be seen lying on the ground and attached to the plant long after the death of vegetative parts. In the herbarium specimens, it is not uncommon to see only one male flower in the leaf-axil but in the living state the flowers are in clusters of 2-3, the largest of which is on a clear pedicel.

Local name: Chibbar, Meki, Takmak

English name: Small gourd

Flowers & Fruits: May-November.

C. melo Linn. var. **momordica** (Roxb.) Duthie & Fuller, Field & Gard. Crops 2: 50. *t.* 49. 1883; Duthie, Fl. Upp. Gang. Pl. 1: 342. 1960, repr. ed.; Maheshwari, Fl. Delhi 170. 1963; Nair, Rec. bot. Surv. Ind. 21(1): 117. 1978; Bhandari, Fl. Ind. Desert 168. 1978. *C. momordica* Roxb. Fl. Ind. (ed. Carey) 3: 720. 1832.

Local names: Kachra, Phunt, Phutt, Phutt Khira.

English name: Snap melon.

Flowers & Fruits: June-September.

C. melo Linn. Sp. Pl. 1011. 1753, var. **melo** Duthie, Fl. Upp. Gang. Pl. 1: 340. 1960, repr. ed.; Maheshwari, Fl. Delhi 169. 1963; Nair, Rec. bot. Surv. Ind. 21(1): 117. 1978.

Local name: Kharbuza.

English name: Musk melon.

Flowers & Fruits: April-September.

C. melo Linn. var. **flexuosus** (Linn.) Naud. Ann. Sci. Nat. ser. 4.ii.34. 1859; Bailey, Man. Cult. Pl. 955. 1949. *C. flexuosus* Linn. Sp. Pl. ed. 2: 1437. 1763. *C. melo* Linn. var. *utilissimus* (Roxb.) Duthie & Fuller,

Field & Gard. Crops 2: 55. *tt.* 53, 54. 1883; Duthie, Fl. Upp. Gang. Pl. 1: 341. 1960, repr. ed.; Maheshwari, Fl. Delhi 170. 1963; Nair, Rec. bot. Surv. Ind. 21(1): 117. 1978. *C. utilissimus* Roxb. Fl. Ind. (ed. Carey) 3: 721. 1832.

Hitherto, in Indian literature this long, snake-like melon has been recorded under the name of *C. melo* Linn. var. *utilissimus* Duthie & Fuller. But as will be clear from the synonymy cited above, it should bear the correct name *C. melo* var. *flexuosus* in accordance with Art. 11 of International Code of Botanical Nomenclature.

Local names: Kakri, Tar.
English names: Snake melon, Serpent melon.
Flowers & Fruits: April-September.

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April 28, 1982.

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32. ON THE IDENTITY OF TWO SPECIES OF *OLDENLANDIA* L. (RUBIACEAE)

Oldenlandia wightii Hook. f. Brit. Ind. 3: 66. 1880 was described on the basis of a collection from Western Peninsula by R. Wight. It was distinguished from *O. umbellata* L. Sp. Pl. 119. 1753 based on capitate cymes, sessile flowers and distant calyx teeth equalling the capsules. In course of taxonomic study of *Hedyotis* L. and *Oldenlandia* L., specimens of both the taxa extant in Indian herbaria and some selected ones from foreign herbaria have been examined. In *O. wightii* Hook. f. (l.c.) the inflorescence is umbellate as evident from the type cited below but erroneously described as capitate with sessile flowers. In *O. umbellata* calyx teeth vary from lanceolate to ovate-lanceolate or triangular. In the early stage of the fruit the calyx teeth are close and lanceolate, but on maturity of capsules they are distant, short and subulate equalling the capsules. Thus the variations observed in *O. umbellata* L. cover the characteristics of *O. wightii* for which the latter cannot be treated as distinct and deserves to be reduced to a synonym. The correct nomenclature of the species is as follows.

Hedyotis puberula (G. Don) Arn. Pug. 342. 1836. *Oldenlandia puberula* G. Don, Gen. Syst. 3: 530. 1834. (Type: Herb. *Heyne* s.n. in *Wall. Cat.* 884! K-W). *O. umbellata* L. Sp. Pl. 119. 1753 (Type: Malabar, Linn. ?). *H. umbellata* Lamk. Tabl. Encycl. 1: 273. 1791. non Walt. 1788. *H. puberula* R. Br. ex Wall. Cat. No. 884. 1829, nom. nud, *H. linearifolia* R. Br. ex Wall. Cat. no. 870. 1829, nom. nud. *O. wightii* Hook. f. Fl Brit. Ind. 3: 66. 1880. (Type: Western Peninsula, Hb. Wight s.n. K photo CAL!) synon. nov.

Oldenlandia maheshwari Sant. et Merch. in Journ. Ind. Bot. Soc. 42A: 213. tt. 1-6. 1964 was distinguished from *O. stocksii* Hook. f. Fl. Brit. Ind. 3: 67. 1880 for having "stem pubescent, flowers solitary, calyx teeth ovate-oblong or oblong, longer than the corolla; corolla smaller ($\pm$ 2 x 1 mm), white or pink in colour. Examination of the type material of *O. stocksii* shows that it bears, *inter alia*, pubescent stem and solitary, axillary or terminal flower; calyx teeth are also sometimes ovate-oblong or oblong and longer than the corolla; corolla varies from 3 mm to 6 mm in length. There are other specimens where the flower is still smaller. Colour of the flower in *O. maheshwarii* is reported to be white or pink while in *O. stocksii* it is blue. It cannot be checked on herbarium specimens and there is hardly any record of flower colour available in the herbarium. It is white or pink in *O. maheshwarii* indicating variation, and taxonomic differences cannot stand on colour of the flower only. Thus none of the differences noted by Santapau and Merchant stand and the distinctions of the taxa are not tenable. Hence it is relegated to a synonym. The nomenclature is as follows.

Hedyotis stocksii (Hook. f.) Rolla Rao et Hemadri in Ind. For. 99(6): 378. 1973. *O. stocksii* Hook. f. Fl. Brit. Ind. 3: 67. 1880. (Syntypes: Concon, *Stocks* s.n.! K.; Malabar, Bababudan Hills, *Stocks* s.n.! K, CAL; ibid. *Lawson* s.n.! K). *H. stocksii* Hook. f. & Thoms. in Sched.! (CAL, K). *O. maheshwarii* Sant. et Merch. in Journ. Ind. Bot. Soc. 42A: 213. tt. 1-6. 1964. (Type: Mahabaleshwar, 13th Sept. 1959, *Y. A. Merchant* 1267! BLAT.). *H. maheshwarii* (Sant. et Merch.) Rolla Rao et Hemadri in Ind. For 99(6): 376. 1973, synon. nov.

BOTANICAL SURVEY OF INDIA,
CALCUTTA - 700 064,
August 16, 1982.

D. B. DEB
RATNA DATTA

33. *CEROPEGIA PUSILLA* WIGHT ET ARN. (ASCLEPIADACEAE) IN HOSHIARPUR DISTRICT (PUNJAB)

During the course of identification of some undetermined specimens of Hoshiarpur district (Punjab), I found an interesting material of the genus *Ceropegia* L. which on examination turned out to be *Ceropegia pusilla* Wight et Arn. The specimen is known only from Nilgiris and Anamalai hills in South India (Hook. f. 1883) and has not been reported so far from Northern India. It is recorded here for the first time from Punjab in North-Western India and has not been included in the recent Flora reported by Nair (1978) from Punjab. Because of its botanical interest and rarity the report is appended here with a short description.

Ceropegia pusilla Wight et Arn. in Wight, Contrib. 31. 1834; Hook. f. Fl. Brit. Ind. 4: 66. 1883; Fyson, Fl. Nilgiri Pulney Hill. 1: 285. 1915.

Dwarf puberulous, tuberous herbs. Stems *c.* 10 cm high, distinctly swollen at nodes. Leaves crowded on the stem, opposite, 1.5-3.0 x 0.4-0.8 cm, linear-lanceolate, acute, narrowed at the base. Peduncle with linear bract at base. Flowers 1-3, light pink, erect. Sepals 3-4 mm long, linear. Corolla *c.* 12 mm long with swollen, angled base. Coronal lobes 5, triangular, acute, somewhat hairy; processes narrowly linear. Corona dark purplish brown with 10, white-ciliate teeth. Stamens thick erect and separate from the stylar head, except at the base. Follicles narrowly fusiform, *c.* 5 cm long.

Flowers and Fruits: August-October.

Distribution: Nilgiris and Anamalais hills.

Present report: Hoshiarpur Distt. (Punjab).

Specimens examined: Punjab: Manguwal, 27.8.1970, *Misra* 41581 (BSD).

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NORTHERN CIRCLE,
3, LAKSHMI ROAD,
DEHRA DUN,
July 22, 1982.

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SURENDRA SINGH

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34. TWO NOTEWORTHY PLANTS FROM WEST BENGAL

Two plants, namely *Nervilia macroglossa* (Hook. f.) Schltr. (Orchidaceae) and *Aeginetia pedunculata* Wall. (Orobanchaceae) have been reported here as new records to W. Bengal. Relevant field data and notes have been presented here along with short descriptions.

INTRODUCTION

During the botanical collections for economic plants and plant-products of Jalpaiguri district in the months of April-May and November 1981, we came across two rare and interesting plants which deserve special care for conservation in their natural habitat due to their rarity and dis-continuous distribution. The species are enumerated below with correct nomenclature, diagnostic features and relevant field data. The herbarium specimens and photographs are deposited in the herbarium (BSIS) of Industrial Section, Botanical Survey of India, Calcutta.

ENUMERATION

ORCHIDACEAE

Nervilia macroglossa (Hook. f.) Schlechter in Engl. Bot. Jahrb. 45: 402 (1911); Hara, H. in Fl. E. Himal. I: 445 (1966), Phot.-Alb. Pl. E. Himal. f. 128 (1968). *Pogonia macroglossa* Hook. f. in Fl. Brit. India vi: 120 (1890), Icon. Pl. t. 2195a (1894); King *et* Pantling in Orch. Sikkim-himal. 267. t. 356 (1898).

Small tuberous terrestrial orchid, growing in open or shady loamy grassland. Flowering stem 7.5 to 15 cm. long; leaf cordate, entire; flower solitary at top of the stem, about 2.5 cm. long. Sepals linear lanceolate, green subequal to petals. Petals linear lanceolate, white, minutely streaked with rose colour; lip gibbous 2.1-2.2 cm. long, distinctly linear than sepals, apical half expanding with two obscure side lobes near its base. Upper surface having, in addition to rose coloured streaks, deep rose coloured spots.

Flowering: April-May.

Distribution: Subtropical Himalayas (Sikkim).

Hara (1966) has remarked "this was collected at one spot under sparse forest" from Sikkim Himalayas. Matthew (1966) has reported from Kurseong (W.B.), a species, *Pogonia macroglossa* Lindl. without citing any herbarium specimens which could not allow the verification of the identity of the specimens referred by him. We could not trace any herbarium specimens, collected from trace any herbarium specimens, collected from Kurseong after critical search in the herbaria (CAL & BSIS).

Further, the works of Krishna *et al.* (1967) and Mukerjee (1972) did not report this plant from North Bengal. So, the occurrence of this plant may be considered as the new record from the plains of W. Bengal.

Specimens examined: A Meebold 4163 (CAL), Mangpoo, May, 1905; Kari 1036 (CAL), Mangpoo, 14.4.1909; S.N.D. *et* S.C.R. 3748 (BSIS), on the wet grassland of Siltosha Beat, Jaldapara wild life Sanctuary (Jalpaiguri district), 3rd May, 1981.

OROBANCHACEAE

Aeginetia pedunculata Wall. in Pl. As. Rar. III: 13, t. 219 (1831); Hook. f. in Fl. Br. India IV: 320 (1885); Kanjilal *et al.* Fl. Assam III: 385 (1939); Gamble, J. S. in Fl. Pres. Mad. II (Reprint edd.): 685 (1956).

A parasitic herb on the roots of grass, growing as solitary plant in wet loamy grassland. Plant with a short stem of 7.5 to 15 cm high, reddish, buried in the soil; leaf not present. Scape short slender, one flowered; peduncle with sheathing obtuse bracts at the base; calyx fleshy, red and then yellow-white, loaded with mucilage, tip obtuse, acute or shortly beaked; corolla tube as long as calyx, yellowish, lobes bright violet, crenate and erose; anthers with dorsal fleshy decurved horn; stigma pelted, broadly cordiform.

Flowering: April-May.

Distribution: Throughout India.

This plant is little known due to its rarity. From W. Bengal this collection is the first report of its occurrence in this area. It may also be noted that we could not trace any herbarium specimens of this species from any part of W. Bengal in the herbaria (CAL & BSIS) after a thorough search.

Specimen examined: S.N.D. *et* S.C.R. 3749, Siltosha beat, Jaldapara wild life sanctuary, Jalpaiguri district, 3rd May, 1981.

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April 12, 1982.

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35. ABNORMAL FLOWERING OF *AGAVE ANGUSTIFOLIA* HAW.

(*With a plate*)

Agave angustifolia Haw. (Agavaceae) — a commonly cultivated plant of the tropics, whose habitat is not known, was found to flower abnormally at Poona, where it is naturalised along the cultivated fields and in wastelands.

In normal cases, the plant bears a basal rosette of numerous large leaves (upto 75.0 x 7.5 cm) on a short, 10-40 cm high, erect or ascending stem. The plant is normally monocarpic and dies after the flowering. At the time of flowering a large cylindrical, bamboo

like peduncle arises from the rosette, which bears flowers on terminal branches. Fruits usually develop *in situ* and form bulbils, which separate away from the parent plant and develop into new plants.

In one of the plants observed many germinated bulbils were seen at the apex of the peduncle (*c* 2.5 m high) of the parent plant. These bulbils were well established on the parent plant and had developed upto 10 leaves which were upto 15.0 x 5.0 cm in size. These so called secondary plants, which were formed from the bulbils of the parent plant were also in turn found to be flowering. At the time of flowering they formed slender, upto 75.0 cm long panicles. Fruits were also formed as in the normal cases (plate 1). In another plant, some of these fruits had germinated *in situ* forming bulbils which eventually developed into tertiary plants (plate 1).

This abnormal germination and flowering of the bulbils on the peduncle of the parent plant showed that the parent plant did not die after the flowering but on its peduncle, plants of the next generation are borne which also successfully flowered and produced fruits there.

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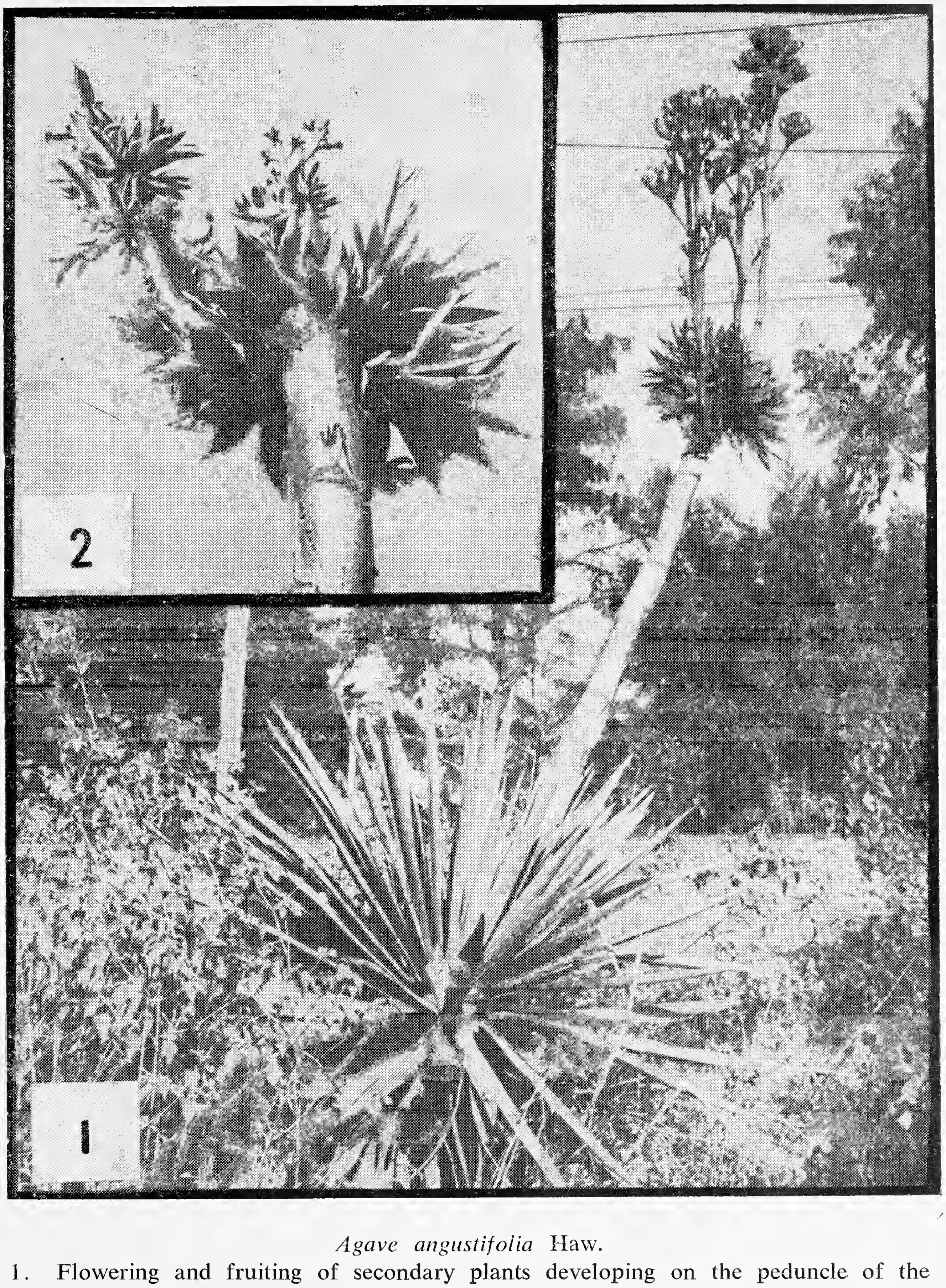
36. GREGARIOUS FLOWERING OF *CARVIA CALLOSA* BREMEK AND *NILGIRIANTHUS RETICULATUS* BREMEK AT AMBOLI

The BNHS nature camp at Amboli from the 25th of September 1982 to the 28th of September 1982 was well attended by its members. Nestling in the ranges of the Sahyadris, Amboli is a beautiful mountain resort in Sindhudurg district, at an altitude of 700 metres. While trekking through lush green hills and valleys, the members saw many species of birds, butterflies and flowering plants. Here, the end of September is the tail end of the monsoon and we had two clear days, but also two days of intermittant rain.

A trek through the moist evergreen forest at Ramghat on the 25th of September revealed the gregarious flowering of *Carvia callosa*, Bremek (Vern. *Karvi*). The undergrowth in the region consisted mainly of these plants and most of them were in full bloom with light purple flowers. On the 27th of September, the same phenomenon was observed on Narayangad trail. There were a few patches of plants still in bud, the buds being pinkish in colour. *Karvi* stems are used by the local people for making huts and for fuel. The gregarious flowering of the plant is considered auspicious by some tribes. The honey collected in the forest during such times is known as *Karvi* honey and is sold at a very high price because



Agave angustifolia Haw.

1. Flowering and fruiting of secondary plants developing on the peduncle of the parent plant.
2. Formation of bulbils by secondary plants on the peduncle of the parent plant.

of its medicinal properties. According to the WEALTH OF INDIA — Raw Materials, Vol. X: 57, the leaves are poisonous to man and animals, causing vomiting and inflammation of the mucous membrane of the stomach. But it has been observed that the fresh leaves are used by the people as a palliative for malaria. To prevent vomiting, the hairy part on the veins beneath the leaves, is removed.

The open hillslopes at Parvati hill and Hiranyakeshi were covered with *Nilgirianthus reticulatus*, Bremek (Vern. *Bakara*). During treks through this region on the 26th of September, we saw these plants flowering gregariously. At Hiranyakeshi, some patches were still in bud.

At Amboli, a clear difference in the distribution of the two species was observed. *Carvia callosa* occurred in the forest as an undergrowth species whereas *Nilgirianthus reticulatus* was seen on open hillslopes. On Parvati hill both the species were growing profusely and were in bloom simultaneously, but nowhere was there overlapping of the two species.

The gregarious flowering of *Carvia callosa* takes place at an interval of 7 or 8 (some local people say 10) years (T. Cooke, FLORA OF BOMBAY, Vol. II: 444), whereas the gregarious flowering of *Nilgirianthus reticulatus* occurs at intervals of about 20 years according to local information. It is necessary to keep records of the gregarious flowering of *Nilgirianthus reticulatus*, as according to Shri M. C. Suryanarayan, *Indian Forester* 96: 850 (1970), 16 years life cycle of *Strobilanthes scrobiculata* Dalz. ex Clarke, is the longest among the group Strobilanthinae.

Fr. H. Santapau in his note (1950, *JBNHS*, 49: 320) sought the help of readers in India to observe various species of *Strobilanthes* and report their gregarious flowering. It may be of interest therefore to put down these notes on two different species which have been observed in bloom this year.

I am grateful to Shri M. R. Almeida for confirming the identification of the plants.

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37. *PTERIS SCABRIPES* WALL. EX HOOK. — A NEW FIND FROM INDIA

In course of the revisionary study on the genus of *Pteris* from India, I located a specimen collected by W. G. Craib from Haflong, North Cachar, Assam, housed in CAL herbarium. After careful examination, it is found that it is exactly identical with *Pteris scabripes* Wall. ex Hook., described from Malay Peninsula. This note gives first report of this species from India. Full description is provided in this paper.

Pteris scabripes Wall. (Cat. N. 94, 1828) ex Hook. Spec. Fil. 2: 165, 1858; Holttum, Fern. Malay 2: 399, 1954.

Rhizome erect, sparsely scaly, stipe tufted, purple, 20 to 40 cm long, longest in fertile frond. Frond has a terminal pinnae and 2-3

pairs of lateral pinnae, lateral pinnae similar to apical pinnae. Sterile pinnae 15 cm-18 cm long, 3 cm to 3.5 cm broad, sessile, apex of pinnae 10 cm to 15 cm long, 8 mm to 12 cm broad, apex acuminate, texture coriacious, veins forked at base, parallel, midrib raised on upper surface and grooved; sori continuous along the edges of fertile pinnae except apices of pinnae; spores brown, tetrahedral.

Specimen examined:

Haflong, 800 m, North Cachar, Assam, 24 Aug. 1908, *W. G. Craib* 425 (CAL-8067).

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CRYPTOGAMIC SECTION,
BOTANICAL SURVEY OF INDIA,
P.O. BOTANIC GARDEN,
HOWRAH - 711 103,
WEST BENGAL,
April 22, 1982.

38. STUDIES IN LEGUMINOSAE XXX — FURTHER CONTRIBUTIONS TO *DALBERGIA* L. F. AND *DERRIS* LOUR.

(*With three text-figures*)

INTRODUCTION

Critical examination of the Indian and Burmese specimens of *Dalbergia* L. f. and *Derris* Lour. in the Herbarium, Royal Botanic Gardens, Kew, has enabled me to supplement the taxonomy and distribution of a few species.

Derris elliptica (Wall.) Benth.

This is the only species of economic importance in the genus and is renowned as the 'Tuba root of Commerce'. Rotenone, extracted from the roots, is extensively used as an insecticide. The species is known wild so far from Bangladesh, Burma, Malaysia, Java, Sumatra, Philippines and New Guinea. In India, it is only cultivated for the 'Tuba root'. Thothathri (1976) reported its wild occurrence in the Great Nicobar Island. *D. elliptica* var. *chittagongensis* Thoth., originally described from Chittagong, Bangladesh, has also been reported in India from Assam (Thothathri 1960). Recently I examined a collection (Fig. 1) from Rattenpur, Cachar District, Assam, which also proved to be *D. elliptica* and the first record of var. *elliptica* wild in India. Future intensive explorations in eastern India may extend its distribution further.

A climber. Branches lenticellate, glabrous. *Leaves* up to 40 cm long; leaflets 9, 13-16 x 5-6 cm, lower pair always smaller than upper, leaflets oblong to obovate-oblong, entire, narrowed at base, acute to shortly acuminate at apex, coriaceous, puberulous below; lateral veins 10-12 pairs, ascending; petiolules grooved above, 5-8 mm long. *Infructescence* incomplete, rachis 22 cm long, glabrous, main peduncle 6-9 mm long, each bearing 2-3 stalked pods; stalks 8-10 mm long, peduncles and stalks glabrous to puberulous. *Pods* oblong, 6.5-10.0 x 2.5-3.0 cm, distinctly winged along the upper suture with a narrow wing on the lower suture, narrowed at base, obtuse at apex, faintly reticulated, puberulous, 1-2-seeded.

INDIA: Assam, Cachar, Rattenpore, 1873, *Maneek* for *R. Keeman* (K).

Fig. 1. *Derris elliptica* (Wall.) Benth. Fruiting branchlet.

Fig. 2. *Derris benthamii* Thw. var. *wightii* (Baker) Thoth.
A. Habit with flowers. B. A twig with pods. C. Calyx-tube. D. Vexillum, wings and keels. E. Staminal column. F. Pistil.

Derris benthamii Thw. var. **wightii** (Baker) Thoth.

This variety has been known only from the fruits, with its floral characters undescribed. Recently a collection from Kalakkadu Forest, Tamil Nadu, by Oates has enabled me to furnish details of floral parts and an illustration (Fig. 2).

Inflorescence terminal and axillary panicles, up to 19 cm long, rachis and branches ferruginous. *Flowers* 7-8 mm long; bracts linear; bracteoles oblong, at the base of the calyx-cup; pedicels 2.0-2.5 mm long. *Calyx* campanulate, 2.5-2.8 mm, densely ferruginous without; mouth entire to faintly toothed. *Vexillum* obovate, 9-10 mm long, emarginate, shortly clawed, wholly glabrous within, silky pubescent without above; wings boat-shaped, 9-10 mm long, auricled below, clawed; keels narrowly oblong, 9-10 mm long, long-clawed, auricled below. *Stamens* 10, monadelphous, sheath 10-11 mm, vexillary filament free below and above, longer filaments alternating with shorter filaments. *Ovary* linear, 9-10 mm long, pubescent, 3-4-ovuled; style slender; stigma capitate; ovules 0.3 mm across.

INDIA: Tamil Nadu, Thirunelveli District, Kalakkadu Reserve Forest (Near Settlement of Kakachi), 1300 m, 1976, *J. F. Oates* 136 (K).

Dalbergia mimosoides Franch.

Originally described from China, *D. mimosoides* is known to occur in India also (Assam, Sikkim). A collection of this species from Burma by Kingdon-Ward constitutes a new record. The field notes read as follows: "A shrub, 25 feet in forests and on open sunny slopes. A scrambler with long and thick stems growing in thickets among which it finds support. The branches are also sensitive to contact and appear to grow in a curve forming a hook even without the stimulus of contact. If they come in contact with a support they form real woody tendrils".

Scambling shrubs, 8 m. Branches glabrous. *Infructescence* axillary and terminal, racemose. *Pods* oblong, 3.5-5.0 x 1.0-1.2 cm, yellowish, distinctly stalked, obtuse and mucronate at apex, glabrous, smooth (without reticulations), 1-2-seeded (Fig. 3).

BURMA: Tsangpo Gorge (Gerupa Le), 1500-1800 m, Dec. 1924, *F. Kingdon-Ward* 6375 (K).

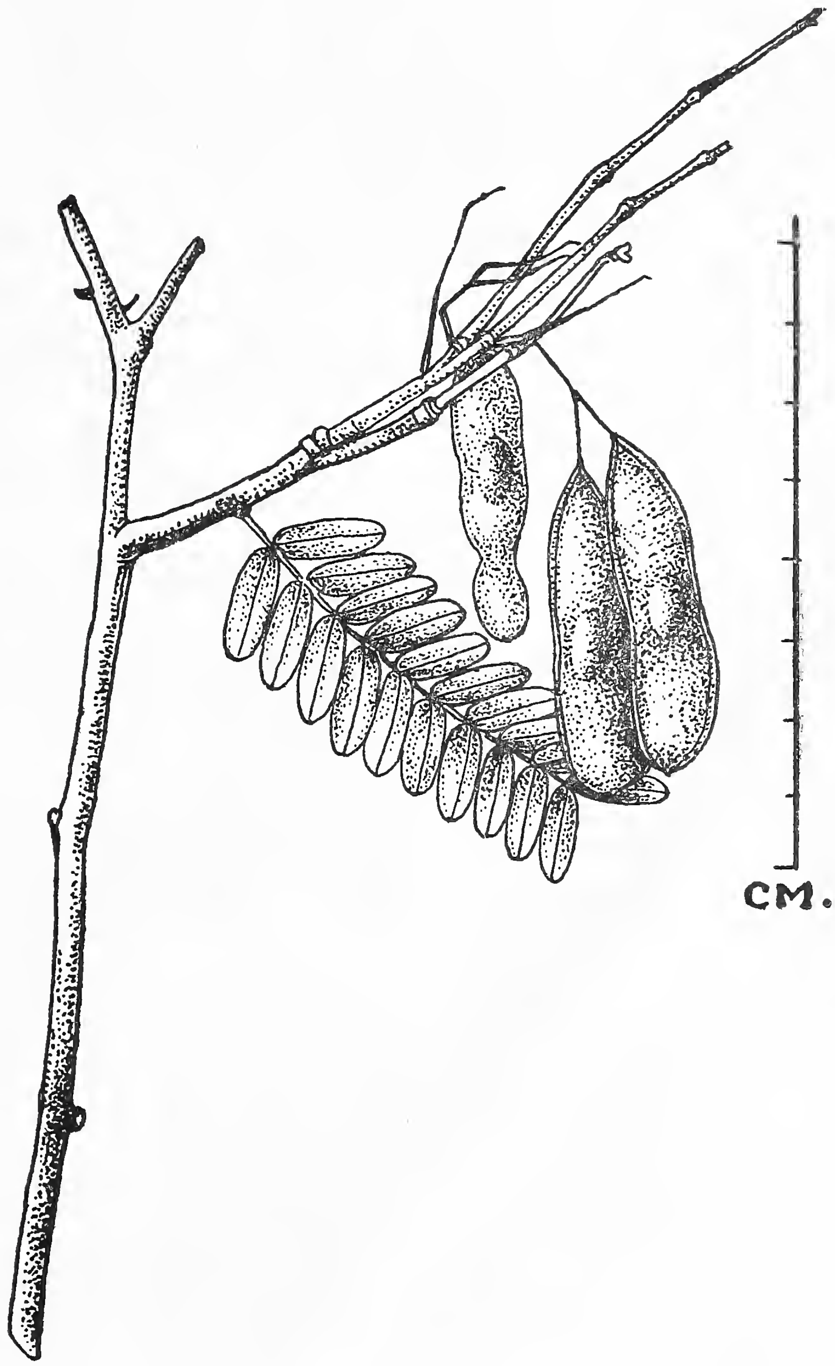

Fig. 3. *Dalbergia mimosoides* Franch. Fruiting branchlet.

ACKNOWLEDGEMENT

I gratefully acknowledge the loan of materials from the Director, Royal Botanic Gardens, Kew, England.

K. THOTHATHRI

BOTANICAL SURVEY OF INDIA,
CENTRAL NATIONAL HERBARIUM,
P.O. BOTANIC GARDEN,
HOWRAH - 711 103 (W.B.),
August 11, 1982.

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ERRATA

VOLUME 80, NO. 1: APRIL 1983

A Catalogue of the Birds in the Collection of Bombay Natural History Society — 27

On page 157,

For 1330 **Garrulax erythrocephalus erythrocephalus** (Hume)

Read 1330 **Garrulax erythrocephalus erythrolaema** (Hume)

VOLUME 80, NO. 3: DECEMBER 1983

Misc. Note No. 6. Additions "to the Birds of Goa by Robert B. Grubh & Sálim Ali JBNHS — Vol. 73, No. 1"

On page 639 — Sr. No. 22

For *Sturnus erythropygius* (Blyth). Whiteheaded Myna

Read *Sturnus malabaricus blythii* (Jerdon). Whiteheaded Myna

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Editors: J. C. Daniel, P. V. Bole & A. N. D. Nanavati

AUGUST 1984 Rs. 45

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EDITORS,
Journal of the Bombay Natural History Society.

VOLUME 81(2): AUGUST 1984

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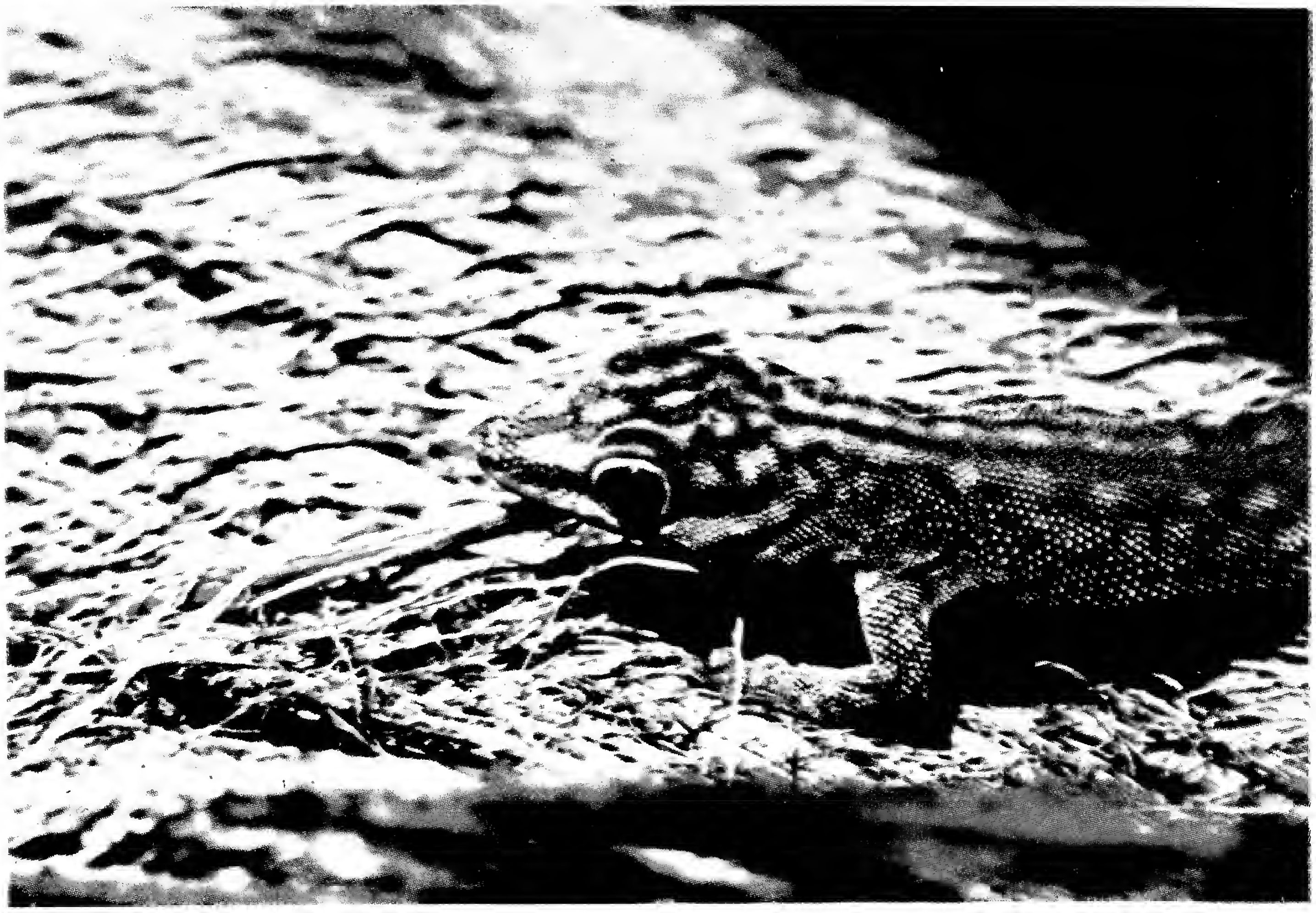


Above: P. befotakensis sp. nov., one of the type specimens (alive).
Below: P. chekei sp. nov., male. (Courtesy of Mr.U.Hoesch).

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1984 AUGUST | Vol. 81 | No. 2

ON THE TAXONOMY OF THE INDIAN OCEAN LIZARDS OF THE *PHELSUMA MADAGASCARIENSIS* SPECIES GROUP (REPTILIA, GECKONIDAE)[1]

ACHIM — RÜDIGER BÖRNER AND WALTER MINUTH[2]

(*With a colour and a monochrome plate & two text-figures*)

INTRODUCTION

The taxonomy and phylogeny of the *Phelsuma madagascariensis* species group still contain vexed problems due to the wide dispersal of these geckos in the Indian Ocean, to inadequate samples from many localities in Madagascar and the rather remote, far-flung islands and to a certain lack of in-depth study of the available specimens and photos. Earlier authors (Angel, Boettger, Boulenger, Loveridge) regarded the taxa of the species group as varieties of *Phelsuma madagascariensis*; Rendahl's paper constituted a major step forward, as he clarified the situation of the sibling species in the Seychelles, but his conclusions were fully accepted only in recent times. Cheke's paper on the taxonomy of the *Phelsuma* of the Seychelles (Cheke 1982) gives a full account of the research history, which will not be repeated here. While Cheke's approach is biogeographical (cf. Cheke in press), our aim is to discuss the phylogeny of the species group in view of supplementary findings.

MATERIAL AND METHODS

This paper is based on a study of:

1) specimens and photos obtained by Mr. Humayun Abdulali on the Andaman Islands in 1976, by Mr. Anthony S. Cheke on the Seychelles in 1976, by Mrs. Eva Minuth and Dr. Walter Minuth in northwest Madagascar in 1977;

[1] Accepted April 1982.

[2] Zülpicher Str. 83, D-5000 Cologne 41, West Germany.

2) specimens and photos communicated by numerous contributors which are mentioned in the list of materials examined;
3) living specimens, partly collected on the above mentioned excursions, partly obtained from third collectors, partly bred by one of us (W. M.)

All alcohol specimens are listed under the serial number of the junior author's collection (BSRC) and are stored in this collection except those transferred to the British Museum (Natural History) BM (NH) as indicated.

BSRC Geck 7 SC
Majunga, Malagasy Rep.
leg. H. Meier; rec. J. H. Brown 15.8.1975
d. J. H. Brown 30.5.1976.

BSRC Geck 8 SC
Praslin Island, Seychelles
leg. H. Meier; rec. J. H. Brown 15.8.1975
d. J. H. Brown 15.2.1976

BSRC Geck 27 SC
Félicité or La Digue Island
leg. Anthony S. Cheke November 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 28 SC BM (NH) 1980. 357
probably Félicité Island, Seychelles
leg. Anthony S. Cheke November 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 29 SC BM (NH) 1980. 352
? North Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 30 SC
Frigate or Silhouette Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 31 SC
Frigate or Silhouette Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 32 SC
? Silhouette Island, Seychelles
leg. Anthony S. Cheke November 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 33 SC
Félicité Island, Seychelles
leg. Anthony S. Cheke 21.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 35 SC
Beau Vallon, Mahé Island, Seychelles
leg. Anthony S. Cheke 14.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 36 SC
Frigate Island, Seychelles
leg. Anthony S. Cheke 8.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 38 SC BM (NH) 1980. 355
Beau Vallon, Mahé Island, Seychelles
leg. Anthony S. Cheke 14.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 40 SC BM (NH) 1980. 353
Frigate Island, Seychelles
leg. Anthony S. Cheke 8.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 41 SC
Frigate Island, Seychelles
leg. Anthony S. Cheke 8.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 42 SC
Anna La Passe, Silhouette Island, Seychelles
leg. Anthony S. Cheke 5.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 43 SC
La Digue Island, Seychelles
leg. Anthony S. Cheke 19.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 44 SC
La Digue Island, Seychelles
leg. Anthony S. Cheke 19.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 45 SC BM (NH) 1979. 489
Félicité Island, Seychelles
leg. Anthony S. Cheke 21.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 46 SC BM (NH) 1980. 358
La Digue Island, Seychelles

leg. Anthony S. Cheke 19.11.1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 47· SC BM (NH) 1980. 356
probably Félicité Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 48 SC
most probably Beau Vallon, Mahé Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 49 SC
North Island, Silhouette Island or Frigate Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 50 SC
North Island, Silhouette Island or Frigate Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 51 SC
North Island, Silhouette Island or Frigate Island, Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 68 SC
Menai, Cosmoledo Atoll, Indian Ocean
leg. P. Niedzwiedski October 1977
d. Anthony S. Cheke 7.9.1980

BSRC Geck 69 SC
Menai, Cosmoledo Atoll, Indian Ocean
leg. P. Niedzwiedski October 1977
d. Anthony S. Cheke 7.9.1980.

BSRC Geck 70 SC
Mahé, Seychelles
leg. U. Hoesch April 1981
d. W. Minuth July 1981

BSRC Geck 71 SC
La Digue, Seychelles
leg. U. Hoesch April 1981
d. W. Minuth July 1981

BSRC Geck 72 SC
La Digue, Seychelles
leg. U. Hoesch April 1981
d. W. Minuth July 1981

BSRC Geck 73 SC
La Digue, Seychelles
leg. U. Hoesch April 1981
d. W. Minuth July 1981

BSRC Geck 74 SC
La Digue, Seychelles
leg. U. Hoesch April 1981
d. W. Minuth July 1981

BSRC Geck 80 SC
Befotaka, Madagascar
leg. W. & E. Minuth August 1977
d. W. Minuth July 1981

BSRC Geck 81 SC
Befotaka, Madagascar
leg. W. & E. Minuth August 1977
d. W. Minuth July 1981

BSRC Geck 82 SC
Befotaka, Madagascar
leg. W. & E. Minuth August 1977
d. W. Minuth July 1981

BSRC Geck 8 MC
no locality
leg. W. Minuth; rec. J. H. Brown 15.8.1975
d. J. H. Brown 21.5.1976

BSRC Geck 13 MC
no locality
d. J. H. Brown 30.5.1976

BSRC Geck 20 MC
close vicinity of Diégo Suarez, Malagasy Republic
leg. H. Meier
d. J. H. Brown 30.5.1976

BSRC Geck 33 MC
close vicinity of Diégo Suarez, Malagasy Republic
leg. H. Meier; rec. J. H. Brown 2.4.76-19.10.76
d. J. H. Brown 28.4.1977

BSRC Geck 36 MC
Diégo Suarez, Malagasy Republic
leg. H. Meier; rec. André Brunke
d. J. H. Brown 28.4.1977

BSRC Geck 43 MC BM (NH) 1980. 351
Seychelles
leg. Anthony S. Cheke Nov. 1976
d. Anthony S. Cheke 19.6.1977

BSRC Geck 44 MC
could be Frigate or Silhouette Island

	Seychelles leg. Anthony S. Cheke Nov. 1976 d. Anthony S. Cheke 19.6.1977
BSRC Geck 45	MC ? Mahé Island, Seychelles leg. Anthony S. Cheke Nov. 1976 d. Anthony S. Cheke 19.6.1977
BSRC Geck 53	MC no locality leg. Rolf Heckhoff 2.4.1979 d. W. Frank 23.6.1977
BSRC Geck 55	MC no locality d. G. Terstappen 22.9.1979
BSRC Geck 56	MC no locality d. W. Frank 23.6.1977

The data for the morphometric tables have been double-checked to prevent errors. Abbreviations in the morphometric tables are the following :

specimen — gives collection number;
SVL — snout-vent-length, calipered to the nearest millimeter;
TL — tail-length, calipered to the nearest millimeter;
LH — length of head from the tip of the snout to the distal edge of the ear opening;
RE — length from rostral to eye, i.e. from the tip of the snout to the distal edge of the eye (eye-ring included);
NE — length from the nostril to the distal edge of the eye (eye-ring included);
WH — width of head, calipered in the widest point of the head by gently pressing the calipers to the sides of the head (scales and skull);
HH — height of head, calipered in the widest point of the head by gently pressing the calipers to the sides of the head (scales and skull);
H — average head granules situated on the snout (nearer to the rostral than to the eyes, upper side of head);
N — nuchal granules close to the occiput near the vertebral line;
D — average dorsal granules 1-2 mm right or left of the vertebral line near middorsum;
L — average lateral granules in the very center of the flanks (equidistant from dorsals and laterals and from fore and hind legs);
V — average ventral scales of the midventer;
G — average gular scales equidistant from a line combining the jaw angles and the ventral scales (ventral neck);
labials — all labials and enlarged granules bordering the mouth;
lamellae — all transversally enlarged scales and all scale rows under the complete rigit;
scansors — all lamellae with adhesive function including a distal terminal lamella and excluding a basal non-adhesive lamella which is set off a little bit from the adhesive pad;
preanal pores — all scales with pores and distinct scutes (= p., mainly in females).

Phelsuma of Malagasy and the Indian Ocean Islands

1. Phelsuma andamanensis

BSRC Geck 12-14 SC

This species is known only from Port Blair, Andaman Islands, where our three specimens were also collected. This form being the only representative in the eastern Indian Ocean occurs far away from the main distribution of the genus, which is restricted to Malagasy and the western Indian Ocean islands. No *Phelsuma* has been found on the central Indian Ocean islands (Lakkadive and Maldive Islands, Sri Lanka) or on the Chagos Archipelago so that there is a considerable gap in the distribution of the genus which indicates a strong chance that *Phelsuma andamanensis* was accidentally transported to the Andaman Islands.

The morphometric data of our three specimens are given in table 1. The species is characterized by the absence of enlarged postmental scales and the following pattern: Dorsally light green. A red stripe (1 mm wide) from the nostril through the eye to the ear and there is a pre- and interocular red Λ-figure whose tip is in the first third of the snout; there are various spots on the rear of the head, which usually tend to extend trans-

TABLE 1
Phelsuma andamanensis, PORT BLAIR

Specimen BSRC Geck	12 SC	13 SC	14 SC	Variation
sex	♂	♂	♂	
SVL	56	48	42	42 –56
TL	61	"59"	59	59 –61
SVL/TL	1.09	–	1.40	1.09– 1.40
LH	14.3	13.5	13.6	13.5 –14.3
RE	8.1	7.8	7.2	7.2 – 8.1
NE	6.5	6.6	6.3	6.3 – 6.6
WH	9.7	9.0	8.5	8.5 – 9.7
HH	5.9	6.3	6.0	5.9 – 6.3
LH/RE	1.76	1.73	1.89	1.73– 1.89
LH/NE	2.20	2.04	2.15	2.04– 2.15
LH/WH	1.47	1.50	1.6	1.47– 1.6
LH/HH	2.42	2.14	2.27	2.14– 2.42
WH/HH	1.64	1.42	1.42	1.42– 1.64
NE/HH	1.10	1.05	1.05	1.05– 1.10
gran.: H	0.4	0.3	0.3	0.3 – 0.4
N	0.15	0.1	0.1	0.1 – 0.15
D	0.2	0.25	0.2	0.2 – 0.25
L	0.5	0.25	0.2	0.2 – 0.5
V	0.7	0.55	0.5	0.5 – 0.7
G	0.35	0.1	0.1	0.1 – 0.35
L/D	2.5	1	1	1 – 2.5
H.1000/SVL	7.14	6.25	7.14	6.25– 7.14
N.1000/SVL	2.69	2.08	2.38	2.08– 2.69
D.1000/SVL	3.57	5.21	4.76	3.57– 5.21
L.1000/SVL	8.93	5.21	4.76	4.76– 8.93
V.1000/SVL	12.5	11.46	11.90	11.46–12.5
G.1000/SVL	6.25	2.08	2.38	2.08– 6.25
scales around midbody	80	88	90	80 –90
supralabials r/l	11/9	10	10/9	9 –11
sublabials r/l	9/8	10/9	9/8	8 –10
lamellae 4th toe	21	24	23	21 –24
scansors 4th toe	10	15	13	10 –15
lamellae 4th finger	18	20	22	18 –22
scansors 4th finger	10	11	14	10 –14
preanal pores r/l	15/16	14/15	14/13	13 –16

versally. Three red longitudinal bands (0.6-1.0 mm wide) are prominent on the nape, and there may be another two lateral rows of red spots or lines, one on each side of the neck. The anterior and mid-dorsum lack spots. The posterior dorsum and sacrum have irregular red spots (-2.0 mm ϕ), which tend to enlarge and fuse transversally. Underneath, the geckos are yellowish and whitish at least on the throat and the anal and femoral region.

The dorsal pattern is not always visible, and there may be true "concolor" — specimens; they occur in the same Port Blair population.

2. **Phelsuma longinsulae** ssp.

This complex has its center on the western group of the Seychelles, the Mahé group, and on Frigate; Cheke (1982, in press) lists the locality records for the Amirante Islands, from where we lack specimens.

Phelsuma longinsulae is a green *Neophelsuma* species with a reduced lateral pattern, a dark red stripe of 1.5 mm width from the nostril to the eye, a $\wedge$ -figure of -1.0 mm width on the snout, variable red postocular and on back of head spots, light (whitish or reddish) spots on the legs and (fading in adults) on the flanks, a longitudinal pattern of red spots (transversally fusing near sacrum). The morphometric data are given in tables 2 ff. It lacks keeled chest scales; and head is more pointed than in *P. sundbergi* (cf. Cheke, in press).

The type of this species has been collected on Long Island near the harbour of Victoria, Mahé. Cheke has already demonstrated that this typical form occurs on Frigate, too, and that this island may be the true center of distribution of this form, Long Island containing only a small, maybe even short-lived population secondarily transported there, probably by natives. Rendahl's taxon *pulchra* has its type locality on Mahé and his taxon *cousinense* from Cousine Island (near Mahé) is consi-

TABLE 2

DIAGNOSES OF THE SEYCHELLES *Phelsuma longinsulae*

Subspecies	*longinsulae*	*pulchra*	*umbrae*	*rubra*
Island	Frigate	Mahé	Silhouette	North
Specimens	36, 40, 41, 49, 51 SC	35, 38, 48, 70 SC	32, 42, 30 SC	29, 50 SC
Shape	moderate	moderate to robust	slender	slender
SVL	41 –51	49 –59	43 –55	43 –55
LH/RE	1.79- 1.87	1.77– 1.89	1.84– 1.91	1.88– 1.94
LH/WH	1.58– 1.62	1.49– 1.58	1.62– 1.72	1.67– 1.71
L/D	1 – 2.33	2 – 2.5	1.33– 1.5	1 – 2
H.1000/SVL	6.00– 8.77	8.16–10.01	7.27–11.11	6.98– 7.27
D.1000/SVL	2.88– 3.70	2.58– 4.08	4.0 – 5.45	3.64– 4.65
L.1000/SVL	3.66– 7.41	5.17– 9.62	4.65– 7.27	4.65– 7.27
V.1000/SVL	9.26–14.81	10.34–13.79	10.91–13.33	9.09– 9.30
G.1000/SVL	1.85– 2.78	2.73– 3.45	1.82– 2.33	2.33– 3.64
scales around midbody	78 –92	76 –88	76 –98	70 –76
supralabials	8 –11	9 –12	7 – 9	8 – 9
scansors 4th toe	10– 15	12 –14	11 –13	12
lamellae 4th finger	18 –22	21 –23	17 –18	18
scansors 4th finger	9 –13	12 –14	9 –10	10
preanal pores	10 –15	8 –16	6 – 9	—

TABLE 2 (Contd.)

Subspecies	*longinsulae*	*pulchra*	*umbrae*	*rubra*
dorsal ground colour	bright green, sometimes a yellowish cast	dull green, rarely yellowish, sometimes bluish	bright green, sometimes a yellowish cast	bright green
dorsal markings a) colour	dull red	dull red	bright red	bright red
b) pattern posterior dorsum	markings prominent (—2 mm ϕ) and tending to fuse transversally near sacrum	markings prominent (—2 mm ϕ) and tending to fuse transversally near sacrum	many small red markings may coalesc transversally near sacrum, but always not as crudely and conspicuously as in specimens from Mahé or Frigate; markings sometimes form three longitudinal irregular lines; markings fade anteriorly like Frigate	large rounded spots (—1.5 mm ϕ) tending to coalesc longitudinally in three (near sacrum even four longitudinal stripes, which continue throughout the dorsum and may fuse transversally near sacrum
middle and anterior dorsum	markings usually arranged in three poorly defined longitudinal lines; markings fade anteriorly	markings (—1 mm ϕ) definitely in three longitudinal lines; markings fade anteriorly		
Ratio: Ground colour/pattern	red pattern may take 50% of posterior and middle dorsum; almost no pattern anteriorly	like Frigate		red pattern takes most space of total dorsum (50% +)
Flanks (adult specimens)	most white spots fade, leaving a mottling of (whitish or red) and dark greenish (undefined) spots	a) well defined white spots which anteriorly form parallel transversal bars, or b) irregular red brown spots	at least some usually well defined whitish spots, almost like ocelli	like Silhouette

TABLE 3A

Phelsuma longinsulae longinsulae, FRIGATE

Specimen BSRC Geck	36 SC	40 SC	41 SC	Variation
Sex	♀	♂	♂?	
SVL	54	52	41	41 –54
TL	"54"	60	"54"	60
SVL/TL	–	1.15	–	1.15
LH	13.0	13.1	11.0	11.0 –13.1
RE	7.0	7.0	6.0	6.0 – 7.0
NE	5.5	6.4	4.7	4.7 – 6.4
WH	8.1	8.3	6.8	6.8 – 8.3
HH	5.0	5.9	4.4	4.4 – 5.9
LH/RE	1.86	1.87	1.83	1.83– 1.87
LH/NE	2.36	2.05	2.34	2.05– 2.36
LH/WH	1.60	1.58	1.62	1.58– 1.62
LH/HH	2.6	2.22	2.5	2.22– 2.6
WH/HH	1.62	1.41	1.55	1.41– 1.62
NE/HH	1.1	1.08	1.07	1.07– 1.1
gran.: H	0.4	0.4	0.3	0.3 – 0.4
N	0.1	0.15	0.1	0.1 – 0.15
D	0.2	0.15	0.15	0.1 – 0.2
L	0.4	0.35	0.15	0.15– 0.4
V	0.5	0.6	0.4	0.4 – 0.6
G	0.1	0.1	0.1	0.1
L/D	2	2.33	1	1 – 2.33
H.1000/SVL	7.41	7.69	7.32	7.32– 7.69
N.1000/SVL	1.85	2.88	2.44	1.85– 2.88
D.1000/SVL	3.70	2.88	3.66	2.88– 3.70
L.1000/SVL	7.41	5.73	3.66	3.66– 7.41
V.1000/SVL	9.26	11.54	9.76	9.26–11.54
G.1000/SVL	1.85	1.92	2.44	1.85– 2.44
scales around midbody	92	80	88	80 –92
supralabials r/l	11/10	10/9	8/10	8 –11
sublabials r/l	9	6/7	7	7 – 9
lamellae 4th toe	26	20	22	20 –26
scansors 4th toe	13	10	13	10 –13
lamellae 4th finger	–	18	20	18 –20
scansors 4th finger	–	9	12	9 –12
preanal pores r/l	15/15	12/10	12/11 p	10 –15/

dered to be a synonym. So far we follow Cheke's opinion. In order to determine the subspecific variation of *Phelsuma longinsulae,* the junior author has drawn up a detailed description of each specimen (cf. tables 3-7 for morphometric data). The specimens with a definite locality were then lumped together so that a variation was determined. The data for the morphometric variation in the four islands Frigate, Mahé, Silhouette and North —

TABLE 3B

Phelsuma longinsulae longinsulae

Specimen	BSRC Geck	49 SC	51 SC	Total variation of subspecies
sex		♂	♂	
SVL		57	54	41 –57
TL		"59"	"52"	60
SVL/TL		–	–	1.15
LH		14.0	12.0	11.0 –14.0
RE		7.7	6.7	6.0 – 7.7
NE		6.5	5.6	4.7 – 6.5
WH		8.8	7.5	6.8 – 8.8
HH		6.0	5.5	4.4 – 6.0
LH/RE		1.82	1.79	1.79– 1.87
LH/NE		2.15	2.14	2.0 – 2.36
LH/WH		1.59	1.6	1.58– 1.62
LH/HH		2.33	2.18	2.18– 2.6
WH/HH		1.47	1.36	1.36– 1.62
NE/HH		1.08	1.02	1.02– 1.1
gran.: H		0.5	0.4	0.3 – 0.5
N		0.2	0.1	0.1 – 0.2
D		0.2	0.2	0.1 – 0.2
L		0.25	0.3	0.15– 0.4
V		0.6	0.8	0.4 – 0.8
G		0.1	0.15	0.1 – 0.15
L/D		1.25	1.5	1 – 2.33
H.1000/SVL		8.77	7.41	6.0 – 8.77
N.1000/SVL		3.51	1.85	1.85– 3.51
D.1000/SVL		3.51	3.70	2.88– 3.70
L.1000/SVL		4.39	5.56	3.66– 7.41
V.1000/SVL		10.53	14.81	9.26–14.81
G.1000/SVL		1.75	2.78	1.75– 2.78
scales around midbody		78	86	78 –92
supralabials r/l		8/9	9	8 –11
sublabials r/l		9/8	7/8	7 – 9
lamellae 4th toe		25	25	20 –26
scansors 4th toe		15	13	10 –15
lamellae 4th finger		21	22	18 –22
scansors 4th finger		10	13	9 –13
preanal pores r/l		14/12 p	13/13 P	10 –15/

as derived from these specimens (including males and females for all islands except North Island) — are given in a synoptic table (table 9). Then it was determined, into which variation each of the morphometric and pattern data of a given specimen without exact locality data fitted. As the basic variation data were derived from males and females (except those for North Island), a comparison of the uncertain specimen with a specimen of the same sex regularly shows even clearer results of affinity. The process of assessing the speci-

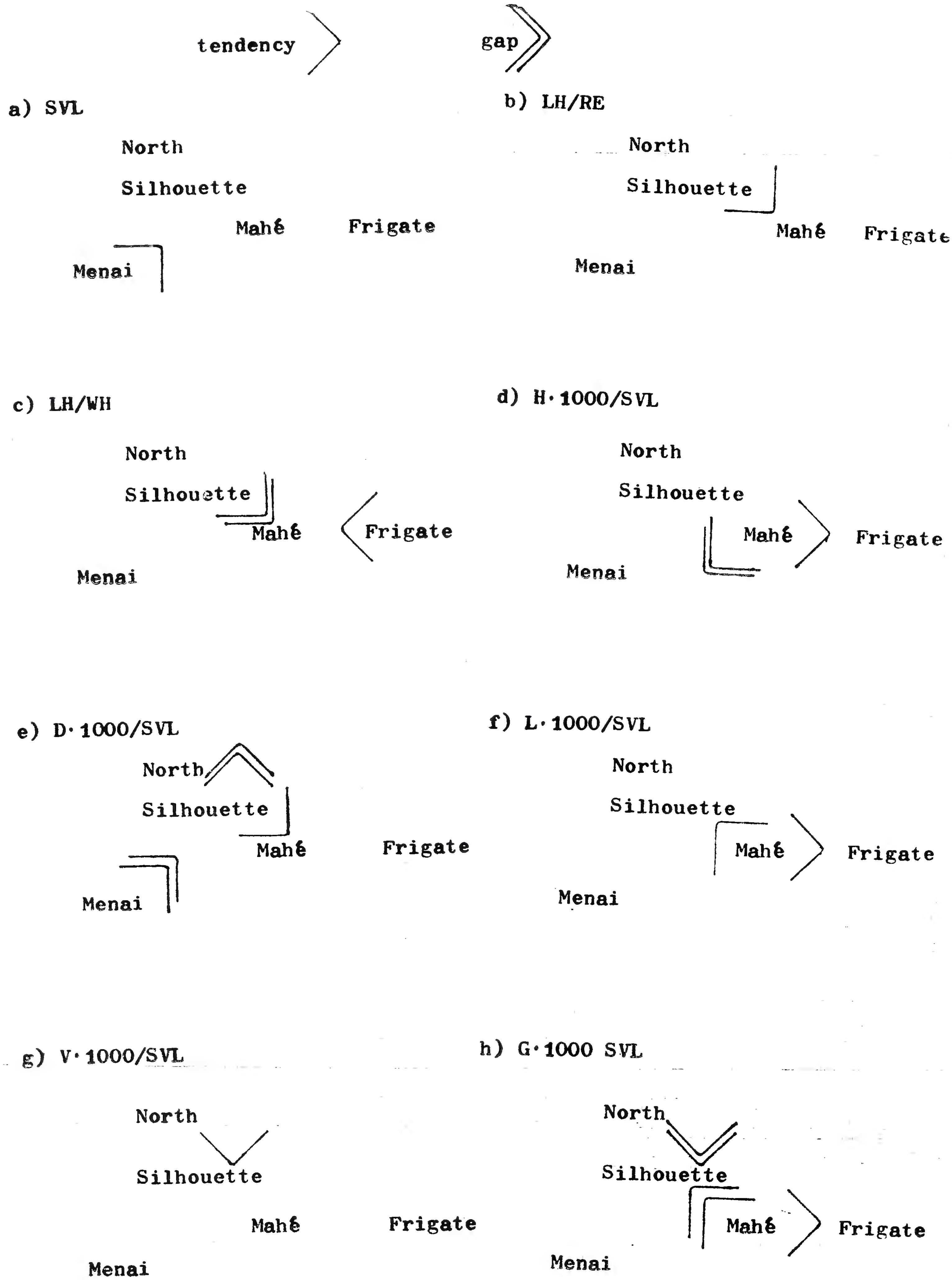


Fig. 1. Character divergence in *Phelsuma longinsulae*.

FIGURE. 1

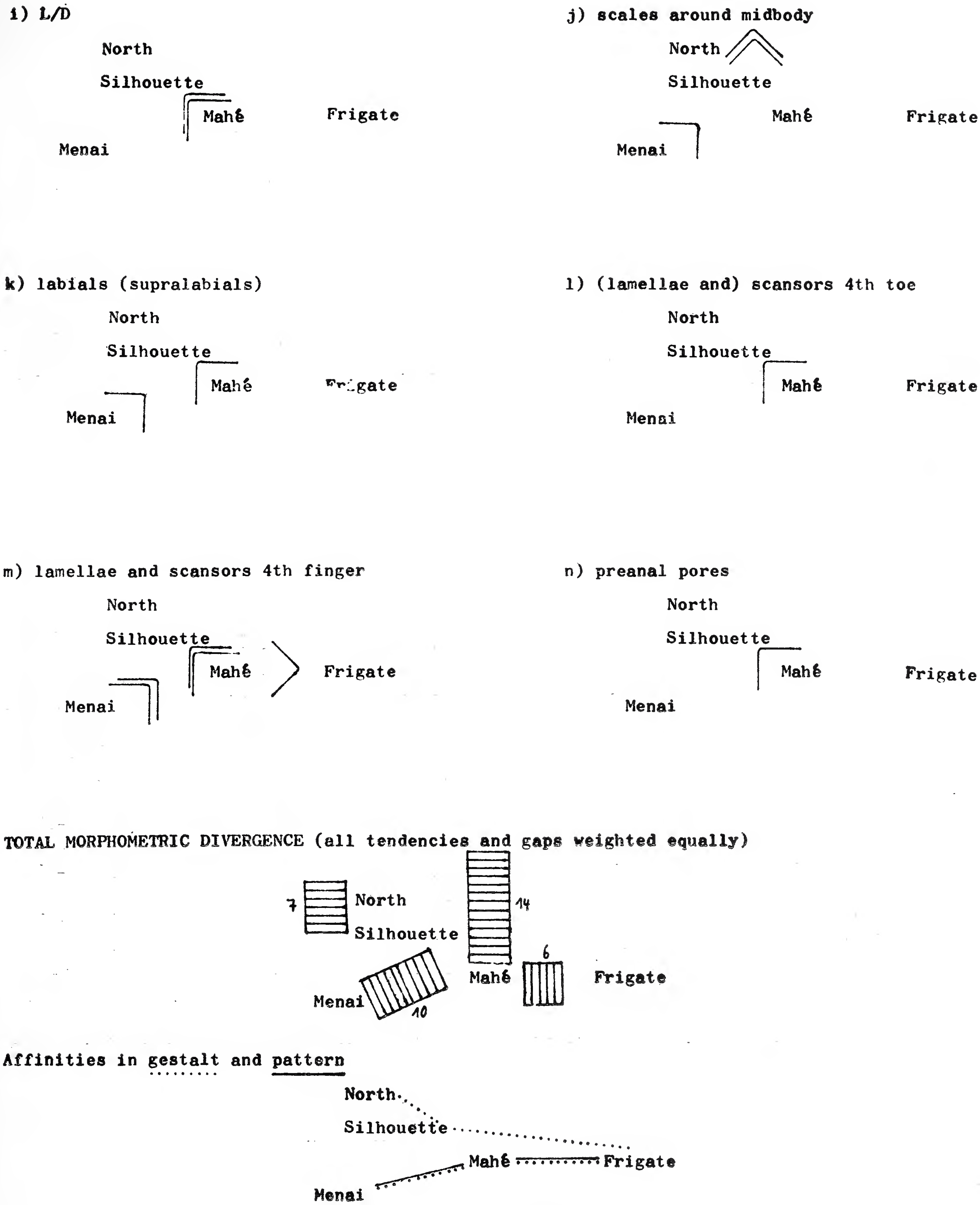


Fig. 1 (contd.)

TABLE 4

Phelsuma longinsulae pulchra, MAHE

Specimen BSRC Geck	35 SC	38 SC	48 SC	70 SC	Variation
sex	♀	♀	♂	♂	
SVL	5.8	5.9	5.5	4.9	4.9 – 5.9
TL	"6.0"	"5.9"	"3.6"	"5.6"	–
SVL/TL	–	–	–	–	–
LH	14.8	14.0	14.0	12.6	12.6 –14.8
RE	8.0	7.9	7.4	6.8	6.8 – 8.0
NE	6.3	6.4	6.1	5.4	5.4 – 6.3
WH	9.6	9.4	9.0	8.0	8.0 – 9.6
HH	6.2	6.4	6.3	5.0	5.0 – 6.4
LH/RE	1.85	1.77	1.89	1.88	1.77– 1.89
LH/NE	2.35	2.19	2.29	2.33	2.19– 2.35
LH/WH	1.54	1.49	1.56	1.575	1.49– 1.58
LH/HH	2.39	2.19	2.22	2.52	2.19– 2.52
WH/HH	1.55	1.47	1.43	1.6	1.43– 1.6
NE/HH	1.02	1	0.97	1.08	0.97– 1.08
gran.: H	0.5	0.5	0.55	0.4	0.4 – 0.55
N	0.1	0.2	0.2	0.1	0.1 – 0.2
D	0.15	0.2	0.2	0.2	0.15– 0.2
L	0.3	0.5	0.5	0.4	0.3 – 0.5
V	0.6	0.8	0.7	0.6	0.6 – 0.8
G	0.2	0.2	0.15	0.15	0.15– 0.2
L/D	2	2.5	2.5	2	2 – 2.5
H.1000/SVL	8.62	9.62	10.01	8.16	8.16–10.01
N.1000/SVL	1.72	3.45	3.64	2.04	1.72– 3.64
D.1000/SVL	2.58	3.45	3.64	4.08	2.58– 4.08
L.1000/SVL	5.17	9.62	9.09	8.16	5.17– 9.62
V.1000/SVL	10.34	13.79	12.73	12.24	10.34–13.79
G.1000/SVL	3.45	3.45	2.73	3.06	2.73– 3.45
scales around midbody	88	76	80	84	76 –88
supralabials r/l	11/12	10/11	9/11	10	9 –12
sublabials r/l	8	9	7	7/8	7 – 9
lamellae 4th toe	28	22	22	24	22 –28
scansors 4th toe	13	14	12	13	12 –14
lamellae 4th finger	23	22	23	21	21 –23
scansors 4th finger	12	12	14	12	12 –14
preanal pores r/l	some p	8/8 p	14/14 p	16/16	8 –16/

mens of uncertain origin is shown in table 10; some specimens could not be assigned to any one population, and consequently their data were included in the total specific variation only. The data of the specimens which were assessed with certainty are included in a second synoptic table giving the variation data for the different islands. Based on this inductive

TABLE 5

Phelsuma longinsulae umbrae

Specimen	BSRC Geck	Silhouette 32 SC	Sihouette 42 SC	Frigate or Sihouette 30 SC	Variation
sex		♀	♂	♀	–
SVL		50	45	55	45 –55
TL		"20"	59	"79"	59
SVL/TL		–	1.31	–	1.31
LH		12.4	12.0	12.9	12.0 –12.9
RE		6.5	6.4	7.0	6.4 – 7.0
NE		5.1	5.5	5.6	5.1 – 5.6
WH		7.5	7.4	7.5	7.4 – 7.5
HH		5.0	5.0	5.4	5.0 – 5.4
LH/RE		1.91	1.87	1.84	1.84– 1.91
LH/NE		2.43	2.18	2.30	2.18– 2.43
LH/WH		1.65	1.62	1.72	1.62– 1.72
LH/HH		2.48	2.40	2.39	2.39– 2.48
WH/HH		1.5	1.48	1.39	1.39– 1.5
NE/HH		1.02	1.1	1.04	1.02– 1.1
gran.: H		0.4	0.5	0.4	0.4 – 0.5
N		0.1	0.1	0.2	0.1 – 0.2
D		0.2	0.2	0.3	0.2 – 0.3
L		0.3	0.3	0.4	0.3 – 0.4
V		0.6	0.6	0.6	0.6
G		0.1	0.1	0.1	0.1
L/D		1.5	1.5	1.33	1.33– 1.5
H.1000/SVL		8.0	11.11	7.27	7.27–11.11
N.1000/SVL		2.0	2.22	3.64	2.0 – 3.64
D.1000/SVL		4.0	4.44	5.45	4.0 – 5.45
L.1000/SVL		6.0	6.66	7.27	6.0 – 7.27
V.1000/SVL		12.0	13.33	10.91	10.91–13.33
G.1000/SVL		2.0	2.22	1.82	1.82– 2.22
scales around midbody		76	90	98	76 –98
supralabials r/l		9/8	9/7	9/8	7 – 9
sublabials r/l		8	8/7	7/8	7 – 8
lamellae 4th toe		21	23	24	21 –24
scansors 4th toe		11	13	12	11 –13
lamellae 4th finger		17	18	18	17 –18
scansors 4th finger		10	9	10	9 –10
preanal pores r/l		9/8	8/6	–	6 – 9

method, we got the results listed in table 11 and accordingly recognize four subspecies in the Seychelles:

Phelsuma longinsulae longinsulae

Frigate; tt : Long Island nr. Mahé
BSRC Geck 36, 40, 41, 49, 51 SC

TABLE 6

Phelsuma longinsulae rubra

specimen BSRC Geck	North 29 SC	North, Frigate or Silhouette 50 SC	variation
Sex	♂	♀	—
SVL	55	43	43 — 55
TL	64	"58"	64
SVL/TL	1.16	—	1.16
LH	13.4	11.3	11.3 — 13.4
RE	6.9	6.0	6.0 — 6.9
NE	5.5	4.7	4.7 — 5.5
WH	8.0	6.6	6.6 — 8.0
HH	5.5	4.6	4.6 — 5.5
LH/RE	1.94	1.88	1.88 — 1.94
LH/NE	2.44	2.40	2.40 — 2.44
LH/WH	1.67	1.71	1.67 — 1.71
LH/HH	2.44	2.46	2.44 — 2.46
WH/HH	1.45	1.43	1.43 — 1.45
NE/HH	1	1.02	1 — 1.02
gran.: H	0.4	0.3	0.3 — 0.4
N	0.1	0.1	0.1
D	0.2	0.2	0.2
L	0.4	0.2	0.2 — 0.4
V	0.5	0.4	0.4 — 0.5
G	0.2	0.1	0.1 — 0.2
L/D	2	1	1 — 2
H.1000/SVL	7.27	6.98	6.98 — 7.27
N.1000/SVL	1.82	2.33	1.82 — 2.33
D.1000/SVL	3.64	4.65	3.64 — 4.65
L.1000/SVL	7.27	4.65	4.65 — 7.27
V.1000/SVL	9.09	9.30	9.09 — 9.30
G.1000/SVL	3.64	2.33	2.33 — 3.64
scales around midbody	70	76	70 — 76
supralabials r/l	8/9	—/8	8 — 9
sublabials r/l	8	7	7 — 8
lamellae 4th toe	—	24	24
scansors 4th toe	—	12	12
lamellae 4th finger	—	18	18
scansors 4th finger	—	10	10
preanal pores r/l	—	—	—

Phelsuma longinsulae pulchra
Mahé, Cousine; tt: Mahé;
Cousin for *cousinense* Rendahl
BSRC Geck 35, 38, 48, 70 SC

Phelsuma longinsulae umbrae, ssp. nov.
tt : Silhouette (d.n.)
Holotype : BSRC Geck 42 SC
Paratypes : BSRC Geck 32, 30 SC

TABLE 7

Phelsuma longinsulae SSPP. (EXCL. *menaiensis*)

Specimen	BSRC Geck	*longinsulae* or *pulchra* 45 MC	*longinsulae* or *pulchra* 31 SC	*longinsulae* or *umbrae* 44 MC	Seychelles 43 MC
sex		♂	♀	♂	♂
SVL		55	56	50	54
TL		63	"50"	"55"	—
SVL/TL		1.15	—	—	—
LH		13.6	13.0	13.0	—
RE		7.7	6.8	7.0	—
NE		6.4	5.8	5.7	—
WH		9.5	8.0	7.8	—
HH		5.8	5.6	5.8	—
LH/RE		1.77	1.91	1.86	—
LH/NE		2.12	2.24	2.28	—
LH/WH		1.43	1.63	1.7	—
LH/HH		2.34	2.32	2.24	—
WH/HH		1.64	1.43	1.34	—
NE/HH		1.10	1.04	0.98	—
gran.: H		0.3	0.4	0.3	0.3
N		0.1	0.1	0.1	0.1
D		0.2	0.2	0.2	0.1
L		0.2	0.1–0.4	0.2	0.3
V		0.4	0.8	0.5	0.7
G		0.1	0.1	0.1	0.1
L/D		1	0.5–2.0	2	1.5
H.1000/SVL		5.45	7.14	6.00	5.6
N.1000/SVL		1.82	1.79	2.00	1.85
D.1000/SVL		3.63	3.57	2.00	3.7
L.1000/SVL		3.63	1.79–7.14	4.00	5.6
V.1000/SVL		7.27	14.29	10.00	12.96
G.1000/SVL		1.82	1.79	2.00	1.85
scales around midbody		80	80	90	82
supralabials r/l		10	10/9	11/10	—
sublabials r/l		8	8/7	8/7	—
lamellae 4th toe		30	30	20	21
scansors 4th toe		18	16	11	12
lamellae 4th finger		21	21	17	—
scansors 4th finger		12	11	9	—
preanal pores r/l		13/12	14/14	14/13	p

Phelsuma longinsulae rubra, ssp. nov.
tt : North Island
(d.n.: the name hints at the conspicuous pattern)
Holotype : BSRC Geck 29 SC
Paratype : BSRC Geck 50 SC

The types are described morphometrically in tables 5 and 6. Diagnoses are given in table 2.

3. **Phelsuma longinsulae menaiensis**
BSRC Geck 68, 69 SC

Cheke (1982) has placed the green *Neophelsuma* from Menai, Cosmoledo Atoll, in the

TABLE 8

Phelsuma longinsulae menaiensis, MENAI

Specimen BSRC Geck	68 SC	69 SC	Variation
sex	♀, 2 eggs	♂	
SVL	5.8	6.1	5.8 — 6.1
TL	"5.6"	"7.6"	—
SVL/TL	—	—	—
LH	14.7	15.4	14.7 — 15.4
RE	8.0	8.5	8.0 — 8.5
NE	6.4	7.4	6.4 — 7.4
WH	9.0	11.0	9.0 — 11.0
HH	6.0	8.3	6.0 — 8.3
LH/RE	1.81	1.81	1.81
LH/NE	2.27	2.08	2.08 — 2.27
LH/WH	1.61	1.4	1.4 — 1.61
LH/HH	2.42	1.86	1.86 — 2.42
WH/HH	1.5	1.325	1.325— 1.5
NE/HH	1.33	0.89	0.89 — 1.33
gran.: H	0.2	0.4	0.2 — 0.4
N	0.1	0.15	0.1 — 0.15
D	0.3	0.3	0.3
L	0.4	0.6	0.4 — 0.6
V	0.8	0.7	0.7 — 0.8
G	0.15	0.2	0.15 — 0.2
L/D	1.33	2	1.33 — 2
H.1000/SVL	3.44	5.56	3.44 — 5.56
N.1000/SVL	1.72	2.46	1.72 — 2.46
D.1000/SVL	5.17	4.92	4.92 — 5.17
L.1000/SVL	6.89	9.84	6.89 — 9.84
V.1000/SVL	13.79	11.48	11.48 — 13.79
G.1000/SVL	2.58	3.28	2.58 — 3.28
scales around midbody	90	88	88 — 90
supralabials r/l	9	8	8 — 9
sublabials r/l	7	8/7	7 — 8
lamellae 4th toe	21	22	21 — 22
scansors 4th toe	13	12	12 — 13
lamellae 4th finger	18	19	18 — 19
scansors 4th finger	11	11	11
preanal pores r/l	11–1–11	15/15	11 — 15/

species *longinsulae*. Indeed this form is hardly distinguishable from *Phelsuma longinsulae pulchra*, which occurs on Mahé. In shape it comes most closely to this lizard, as it is similarly robust. Its meristic data are given in table 8, from which a marked sexual dimorphism in head proportions is evident. In life it is dark green with dull red dorsal markings (-1.6 mm wide) in three irregular longitudinal rows. Legs and flanks are irregularly mottled. The head shows a ∧ -figure, a dark red stripe from the nostril to the eye, and a spotted temple. Underneath the lizard is whitish, the only marks being a grey semi-circular band on the inframaxillary reaching to the ear and some dark gular spots which may form a second inner semi-circle.

4. **Phelsuma chekei,** sp. nov.
   BSRC Geck 36 MC (Holotype),
   20 MC, 33 SC (Paratypes)

These specimens have been purchased from Mr. H. Meier, who collected them in the close vicinity of Diégo Suarez (pers. comm.). We therefore design as *type locality*: vicinity of Diégo Suarez, northern tip of Madagascar; d.n.: The new species is named after Anthony Cheke, a long-time friend of ours.

Diagnosis: The diagnostic meristic data are summarized in table 20.

The new species is rather robust and stout in shape, comparable to the forms of Menai and Mahé on the one hand and to the even

TABLE 9

Phelsuma longinsulae, VARIATION OF SPECIMENS WITH CERTAIN LOCALITY DATA ONLY

taxon specimens BSRC Geck	*rubra* (1) 29 SC	*umbrae* (2) 32, 42 SC	*pulchra* (4) 35, 38, 48, 70 SC	*longinsulae* (3) 36, 40, 41 SC	*menaiensis* (2) 68, 69 SC
SVL	55	45 –50	49 –59	41 –54	58 –61
SVL/TL	1.16	1.16– 1.51	—	1.15	—
LH/RE	1.94	1.87– 1.91	1.77– 1.89	1.83– 1.87	1.81
LH/NE	2.44	2.18– 2.43	2.19– 2.35	2.05– 2.36	2.08– 2.27
LH/WH	1.67	1.62– 1.65	1.49– 1.58	1.58– 1.62	1.4 – 1.61
LH/HH	2.44	2.40– 2.48	2.19– 2.52	2.22– 2.6	1.86– 2.42
WH/HH	1.45	1.48– 1.5	1.43– 1.6	1.41– 1.62	1.325–1.5
NE/HH	1	1.02– 1.1	0.97– 1.08	1.07– 1.1	0.89– 1.33
L/D	2	1.5	2 – 2.5	1 – 2.33	1.33– 2
H.1000/SVL	7.27	8.0 –11.11	8.16–10.01	7.32– 7.69	3.44– 5.56
N.1000/SVL	1.82	2.0 – 2.22	1.72– 3.64	1.85– 2.88	1.72– 2.46
D.1000/SVL	3.64	4.0 – 4.44	2.58– 4.08	1.92– 3.70	4.92– 5.17
L.1000/SVL	7.27	6.0 – 6.66	5.17– 5.62	3.66– 7.41	6.89– 9.84
V.1000/SVL	9.09	12.0 –13.33	10.34–13.79	9.26–11.54	11.48–13.79
G.1000/SVL	3.64	2.0 – 3.33	2.73– 3.45	1.85– 2.44	2.58– 3.28
scales around midbody	70	76 –90	76 –88	80 –92	88 –90
supralabials	8/9	7 – 9	9 –12	8 –11	8 – 9
sublabials	8	7 – 8	7 – 9	7 – 9	7 – 8
lamellae 4th toe	—	21 –23	22 –28	20 –26	21 –22
scansors 4th toe	—	11 –13	12 –14	10 –13	12 –13
lamellae 4th finger	—	17 –18	21 –23	18 –20	18 –19
scansors 4th finger	—	9 –10	12 –14	9 –12	11
preanal pores	—	6 – 9/	8 –16/	10 –15/	11 –15/

TABLE 10

Phelsuma longinsulae, AFFINITIES OF SPECIMENS WITHOUT CERTAIN LOCALITY DATA

specimen	S, F 30 SC	N, S, F 50 SC	N. S, F 49 SC	N, S, F 51 SC
A. SVL	N, S, M, F	N, S, M, F	nr. N, M, nr. F	N, M, F
B. LH/RE	nr. S, M, F	S, M, nr. F	M, nr. F	M, nr. F
LH/NE	S, M, F	S, nr. F	nr. S, nr. M, F	F
LH/WH	nr. S	nr. S	nr. S, nr. M, F	nr. S, M, F
LH/NH	nr. S, M, F	S, M, F	M, F	nr. M, nr. F
WH/HH	nr. M, nr. F	nr. S, M, F	nr. S, M, F	nr. F
NE/HH	S, M, nr. F	S, M, nr. F	S, M, F	nr. N, S, M, nr. F
C. L/D	nr. S, nr. F	nr. S, F	nr. S, F	S, nr. M, F
H.1000/SVL	N, nr. F	nr. N, nr. F	S, M	nr. N, F
N.1000/SVL	N, nr. F	nr. S, M, F	M	nr. N, nr. S, M, F
D.1000/SVL	nr. S	nr. S, M	nr. N, nr. S, M, F	nr. N, nr. S, M, F
L.1000/SVL	nr. S, M, F	M, F	F	nr. S, M, F
V.1000/SVL	M, F	nr. M, F	M, F	nr. M
G.1000/SVL	nr. F	S, nr. M, F	nr. F	S, M, nr. F
scales around midbody	nr. S, nr. F	S, M	S, M, nr. F	S, M, F
supralabials	S, M, F	S, nr. M, F	N, S, nr. M, F	S, M, F
sublabials	S, M, F	S, M, F	nr. N, nr. S, M, F	S, M, F
lamellae 4th toe	nr. S, M, F	nr. S, M, F	nr. S, M, F	nr. S, M, F
scansors 4th toe	S, M, F	S, M, F	nr. S, nr. M, nr. F	S, M, F
lamellae 4th finger	S, M, F	S, F	M, nr. F	M, nr. F
scansors 4th finger	S, F	S, F	S, nr. M, F	M, nr. F
preanal pores	—	—	M, F	M, F
D. pattern	S	N	F	F
E. Characters are in/near/to variation of				
North (only N)	3x	3x (1x)	4x	5x
Silhouette (only S)	17x (3x)	18x (1x)	13x	12x
Mahé (only M)	13x	15x	19x	19x (1x)
Frigate (only F)	19x (1x)	18x	21x (3x)	22x (3x)
F. Subspecific Classification (according to weighted character affinities and subjective impression)	*umbrae* (Silhouette)	*rubra* (North)	*longinsulae* (Frigate)	*longinsulae* (Frigate)

TABLE 10 (*Contd.*)

specimen	F, S 44 MC	F, S 31 SC	Mahé 45 MC	Seychelles 43 MC
A. SVL	N, S, M, F	nr. N, M, nr. F	N, M, F	N, M, F
B. LH/RE	nr. S, M, F	N, S, nr. M, nr. F	M, nr. F	—
LH/NE	S, M, F	S, M, F	F	—
LH/WH	nr. S	nr. N, S, nr. M, nr. F	nr. M	—
LH/NH	M, F	M, F	M, F	—
WH/HH	nr. F	nr. N, nr. S, M, F	nr. M, nr. F	—
NE/HH	nr. N, nr. S, M	S, M, nr. F	S, nr. M, F	—
C. L/D	nr. S, M, F	nr. S, nr. M, nr. F	nr. S, F	S, nr. M, F
H.1000/SVL	nr. F	nr. N, nr. F	to N, to F	to F
N.1000/SVL	nr. N, S, M, F	nr. N, nr. S, M, nr. F	N, nr. S, M, nr. F	nr. N, nr. S, M, F
D.1000/SVL	nr. M, F	nr. N, nr. S. M, F	N, nr. S, M, F	nr. N, nr. S, M, F
L.1000/SVL	F	nr. N, nr. S, M, F	nr. F	nr. S, M, F
V.1000/SVL	nr. M, F	M	to F	S, M
G.1000/SVL	S, F	nr. S, nr. F	nr. S, nr. F	nr. S, F
scales around midbody	S, nr. M, F	S, M, F	S, M, F	S, M, F
supralabials	M, F	nr. N, nr. S, M, F	M, F	—
sublabials	N, S, M, F	nr. N, S, M, F	N, S, M, F	—
lamellae 4th toe	nr. S, nr. M, F	nr. M	nr. M	S, nr. M, F
scansors 4th toe	S, nr. M, F	nr. M	to M	nr. S, M, F
lamellae 4th finger	S, nr. F	M, nr. F	M, nr. F	—
scansors 4th finger	S, F	nr. S, M, F	nr. S, M, F	—
preanal pores	M, F	M, F	M, F	—
D. pattern	S	S	F	?

TABLE 10 (*Contd.*)

Specimen	F, S 44 MC	F, S 31 SC	Mahé 45 MC	Seychelles 43 MC
E. Characters are in/near/to variation of				
North (only N)	4x	10x	5x	2x
Silhouette (only S)	15x (2x)	15x (1x)	8x	9x
Mahé (only M)	14x	20x (3x)	16x (3x)	8x
Frigate (only F)	20x (3x)	19x	19x (4x)	9x
F. Subspecific classification (according to weighted character affinities and subjective impression)	*longinsulae* or *umbrae* (Frigate or Silhouette)	*pulchra* or *longinsulae* (Mahé or Frigate)	*purchra* or *longinsulae* (Mahé or Frigate)	ssp.

A character of a specimen may fall into the variation of a population (as known from the specimens with definite locality data). If the character does not lie within this variation, it may nevertheless approximate it, which is defined as being near that variation ("nr."). Such proximity is assumed, if in relation to the known variation
— a head proportion is 0.05 close,
— a scale proportion is 0.5 close,
— the labial count is 1 scale more or less,
— another scale count is 2 scales more or less
If there is no proximity to any known variation, it is assumed that there is a tendency towards the population whose variation comes closest (= "to").
N = North
S = Silhouette
M = Menai
F = Frigate

TABLE 11

VARIATION OF ALL SPECIMENS

taxon specimens BSRC Geck	*longinsulae* (5) 36, 40, 41, 49, 51 SC	Seychelles (18) 31 SC, 43, 44, 45 MC	*menaiensis* (2) 68, 69 SC	all subspecies (20) all specimens
SVL	41 –57	41 –57	58 –61	
SVL/TL	1.15	1.15– 1.31	—	
LH/RE	1.79– 1.87	1.77– 1.94	1.81	
LH/NE	2.05– 2.36	2.05– 2.44	2.08– 2.27	
LH/WH	1.58– 1.62	1.43– 1.72	1.4 – 1.61	
LH/HH	2.18– 2.6	2.18– 2.6	1.86– 2.42	
WH/HH	1.36– 1.62	1.34– 1.64	1.325–1.5	
NE/HH	1.02– 1.1	0.97– 1.1	0.89– 1.33	
L/D	1 – 2.33	1 –2.5	1.33– 2	
H.1000/SVL	6.00– 8.77	5.45–11.11	3.44– 5.56	
N.1000/SVL	1.85– 3.51	1.72– 3.64	1.72– 2.46	
D.1000/SVL	2.88– 3.70	1.92– 5.45	4.92– 5.17	
L.1000/SVL	3.66– 7.41	3.63– 9.62	6.89– 9.84	
V.1000/SVL	9.26–14.81	7.27–14.81	11.48–13.79	
G.1000/SVL	1.85– 2.78	1.79– 3.64	2.58– 3.28	
scales around midbody	78 –92	70 –98	88 –90	
supralabials	8 –11	8 –12	8 – 9	
sublabials	7 – 9	7 – 9	7 – 8	
lamellae 4th toe	20 –26	20 –30	21 –22	
scansors 4th toe	10 –15	10 –18	12 –13	
lamellae 4th finger	18 –22	17 –23	18 –19	
scansors 4th finger	9 –13	9 –14	11	
preanal pores	10 –15/	6 –16/	11 –15/	

taxon specimens BSRC Geck	*rubra* (2) 29, 50 SC	*umbrae* (3) 32, 42, 30 SC	*pulchra* (4) 35, 38, 48, 70 SC
SVL	43 –55	43 –55	49 –59
SVL/TL	1.16	1.31	—
LH/RE	1.88– 1.94	1.84– 1.91	1.77– 1.89
LH/NE	2.40– 2.44	2.18– 2.43	2.19– 2.35
LH/WH	1.67– 1.71	1.62– 1.72	1.49– 1.58
LH/HH	2.44– 2.46	2.39– 2.48	2.19– 2.52
WH/HH	1.43– 1.45	1.39– 1.5	1.43– 1.6
NE/HH	1 – 1.02	1.02– 1.1	0.97– 1.08
L/D	1 – 2	1.33– 1.5	2 – 2.5
H.1000/SVL	6.98– 7.27	7.27–11.11	8.16–10.01
N.1000/SVL	1.82– 2.33	2.0 – 3.64	1.72– 3.64
D.1000/SVL	3.64– 4.65	4.0 – 5.45	2.58– 4.08
L.1000/SVL	4.65– 7.27	4.65– 7.27	5.17– 9.67
V.1000/SVL	9.09– 9.30	10.91–13.33	10.34–13.79
G.1000/SVL	2.33– 3.64	1.82– 2.33	2.73– 3.45

TABLE 11 (*Contd.*)

scales around midbody	70 –76	76 –98	76 –88
supralabials	8 – 9	7 – 9	9 –12
sublabials	7 – 8	7 – 8	7 – 9
lamellae 4th toe	24	21 –24	22 –28
scansors 4th toe	12	11 –13	12 –14
lamellae 4th finger	18	17 –18	21 –23
scansors 4th finger	10	9 –10	12 –14
preanal pores	—	6 – 9/	8 –16/

stouter form of Assumption (named by Cheke: *Phelsuma abbotti sumptio,* now considered to be a valid species, see below).

The dorsal and lateral scales of body and tail are wide spaced, which is a unique character of this species. The back is dull green to dull blue (olive-green to blue-green in life), sometimes with a dull red-brown broad vertebral line or such spots mainly in the vertebral region. Flanks and legs are brownish with lighter yellowish-brown, rounded spots in a dark grey network. The head has a preocular red semicircle, which continues interocularly; this figure is never V-shaped, but always rounded. On the back of the head there are some irregular, usually transversally enlarged dark redbrown spots. A dark redbrown streak runs from the nostril to the eye and continues behind the eye towards the occiput in a U-shaped figure. A second stripe starts on the second row of postmentals, continues from the inframaxillariae to the posterior labials and to the ear and then forms a second, though interrupted U-figure on the anterior nape. Between these two dark stripes the temple is whitish. A third similar figure is formed by the inner dark stripe of the anterior throat, but this stripe continues to the side of the neck only and is usually not visible there in life. Usually there is a third dark semicircle on the inner throat. All these gular stripes are ventrally dark grey and laterally and dorsally dark redbrown or greybrown. Underneath the animal is white, but may be slightly yellowish in the anal and femoral region.

The meristic data of the holotype, whose pattern has faded in alcohol, are given in table 12.

An earlier description is given by Krefft (1907), cf. also Boettger (1881, part.); Mertens (1964, 1966 part.). Published photos referred to this species are found in Mertens (1962, fig.) and Nietzke (1972, fig. 73). All previous authors have included this species under the name *Phelsuma abbotti.*

5. **Phelsuma befotakensis** sp nov.
BSRC Geck 82 SC (Holotype),
80-81 SC (Paratypes)

Type locality and d.n.: Befotaka, Northwest Madagascar (s. of Presqu' Ile Radama, *c.* halfway between Diégo Suarez and Majunga; not the village on Nosy Bé !).

Diagnosis: The meristic data are given in table 20.

The adhesive pads of the species are not as wide as those of *Phelsuma chekei.*

Ground colour is a bluish green, which in the light phase may turn to a yellowish bright green mid-dorsally and on the sacrum.

A dark redbrown stripe runs from the nostril through the eye and continues upwards through the temple in order to form the dorsolateral redbrown stripe on the nape; it continues as a series of elongated spots which

TABLE 12

Phelsuma chekei, DIEGO SUAREZ

specimen BSRC Geck	20 MC	33 MC	36 MC	variation
sex	♂	♀	♂	—
SVL	58	55	60	55 –60
TL	"65"	52	74	52 –74
SVL/TL	—	0.945	1.23	0.94– 1.23
LH	15.2	13.7	15.4	13.7 –15.4
RE	7.9	7.2	8.6	7.2 – 8.6
NE	7.2	6.2	6.9	6.2 – 7.2
WH	10.5	10.0	11.0	10.0 –11.0
HH	7.2	6.9	6.7	6.7 – 7.2
LH/RE	1.92	1.90	1.79	1.79– 1.92
LH/NE	2.17	2.21	2.23	2.17– 2.23
LH/WH	1.45	1.37	1.64	1.37– 1.64
LH/HH	2.17	1.99	2.30	1.99– 2.30
WH/HH	1.46	1.45	1.64	1.45– 1.64
NE/HH	1	0.90	1.03	0.90– 1.03
gran.: H	0.4	0.5	0.4	0.4 – 0.5
N	0.2	0.2	0.2	0.2
D	0.3	0.3	0.3	0.3
L	0.7	0.5	0.5	0.5 – 0.7
V	0.8	0.8	0.8	0.8
G	0.15	0.15	0.1	0.1 – 0.15
L/D	2.33	1.67	1.67	1.67– 2.33
H.1000/SVL	6.90	9.09	6.67	6.67– 9.09
N.1000/SVL	3.45	2.73	3.33	2.73– 3.45
D.1000/SVL	5.17	5.45	5	5 – 5.45
L.1000/SVL	12.06	9.09	8.33	8.33–12.06
V.1000/SVL	13.79	14.54	13.33	13.33–14.54
G.1000/SVL	2.59	2.73	1.67	1.67– 2.73
scales around midbody	70	68	72	68 –72
supralabials r/l	7/6	8/7	8/9	6 – 9
sublabials r/l	7	8	7/9	7 – 9
lamellae 4th toe	21	21	23	21 –23
scansors 4th toe	10	11	12	10 –12
lamellae 4th finger	19	19	19	19
scansors 4th finger	10	11	11	10 –11
preanal pores r/l	17/17	—	12/14 p	12 –17

separate dorsum and flanks and which may fade in the light phase. A red vertebral stripe starts on the occiput and continues to the base of the tail. A second smaller redbrown stripe, which joins the dorsolateral stripe on the anterior nape, originates in the outer dark chin stripe and runs through the ear. The inner gular stripe is not evident on the sides of the neck. Neck and body show greenish, in the light phase even yellowish rounded spots in

longitudinal rows: one between the vertebral and the dorsolateral redbrown stripes, another below the dorsolateral stripe on the upper flank and a third indistinct one on the lower flank. In the dark phase the light spots on the upper flank are encircled by irregular dark red spots, which gives the impression of ocelli. The same sort of spots are present on the legs. A conspicuous character is a redbrown prefrontal stripe from the scales behind the intranasal granule all along the fore head; before the eyes it merges with a U-shaped inter-

TABLE 13

Phelsuma befotakensis, BEFOTAKA

specimen BSRC Geck	80 SC	81 SC	82 SC	variation
sex	♂	♀	♂	—
SVL	48	44	48	44 –48
TL	*c.* 70	*c.* 60	—	60 –70
SVL/TL	1.46	1.36	—	1.36– 1.46
LH	13.3	13.6	13.0	13.0 –13.6
RE	7.2	7.5	7.0	7.0 – 7.5
NE	6.1	6.4	6.0	6.0 – 6.4
WH	8.1	8.9	9.8	8.1 – 9.8
HH	6.0	5.8	6.3	5.8 – 6.3
LH/RE	1.85	1.81	1.86	1.81– 1.86
LH/NE	2.18	2.12	2.17	2.12– 2.18
LH/WH	1.35	1.52	1.33	1.33– 1.52
LH/HH	2.22	2.34	2.06	2.06– 2.34
WH/HH	1.35	1.53	1.33	1.33– 1.53
NE/HH	1.02	1.10	0.95	0.95– 1.10
gran.: H	0.4	0.5	0.5	0.4 – 0.5
N	0.15	0.2	0.3	·0.15– 0.3
D	0.3	0.4	0.4	0.3 – 0.4
L	0.5	0.5	0.5	0.5
V	0.5	0.8	0.75	0.5 – 0.8
G	0.15	0.25	0.15	0.15– 0.25
L/D	1.67	1.25	1.25	1.25– 1.67
H.1000/SVL	8.33	11.36	10.42	8.33–11.36
N.1000/SVL	3.125	4.54	5.25	3.125–5.25
D.1000/SVL	6.25	9.09	8.33	6.25– 9.09
L.1000/SVL	10.42	11.36	10.42	10.42–11.36
V.1000/SVL	10.42	18.18	15.625	10.42–18.18
G.1000/SVL	3.125	3.41	3.125	3.125–3.41
scales around midbody	78	74	74	74 –78
supralabials r/l	8/7	6/7	9	6 – 9
sublabials r/l	7	7/8	7/6	6 – 8
lamellae 4th toe	20	22	22	20 –22
scansors 4th toe	10	11	13	10 –13
lamellae 4th finger	22	20	18	18 –22
scansors 4th finger	12	10	10	10 –12
preanal pores r/l	15/17	—	10	10 –17/

TABLE 14

VARIATION OF *Phelsuma sundbergi*

specimens BSRC Geck	Praslin (1) 8 SC	Félicité (4) 28, 33, 45, 47 SC	La Digue (8) 43, 44, 46, 71-74, 27 SC	Total (13)
SVL	74	54 –67	62 –77	54 –77
SVL/TL	1.19	—	1.27– 1.28	1.19– 1.28
LH/RE	1.84	1.84– 1.96	1.71– 1.93	1.71– 1.96
LH/NE	2.22	2.2 – 2.33	1.95– 2.37	1.95– 2.37
LH/WH	1.47	1.41– 1.6	1.31– 1.61	1.31– 1.61
LH/HH	2.14	2.05– 2.4	2.08– 2.43	2.05– 2.43
WH/HH	1.46	1.41– 1.51	1.37– 1.65	1.37– 1.65
NE/HH	0.96	0.91– 1.09	0.95– 1.39	0.91– 1.39
L/D	1.67	1.67– 2.5	1.13– 2.5	1.13– 2.5
H.1000/SVL	13.51	7.4 –10.77	7.58–12.31	7.4 –13.51
N.1000/SVL	4.05	1.8 – 4.24	2.46– 4	1.8 – 4.24
D.1000/SVL	4.05	3.28– 4.48	3.03– 5.38	3.03– 5.38
L.1000/SVL	6.76	7.4 – 9.23	5.3 – 8.2	5.3 – 9.23
V.1000/SVL	13.51	8.26–12.31	9.84–15.38	8.26–15.38
G.1000/SVL	4.05	3.28– 4.48	2.64– 4.8	2.64– 4.8
scales around midbody	88	76 –88	88 –100	76 –100
supralabials	10/11	8 –11	8 –10	8 –11
sublabials	8	7 – 9	7 – 9	7 – 9
lamellae 4th toe	22	23 –29	21 –31	21 –31
scansors 4th toe	11	13 –16	10 –18	10 –18
lamellae 4th finger	—	19 –26	19 –25	19 –26
scansors 4th finger	13	11 –16	10 –17	10 –17
preanal pores	13–14	13 –15	10 –16	10 –16

ocular series of spots. A second series of spots forms an opposite U with the tip on the occiput and the ends on the supraocular scales. Underneath the animal is yellowish white, with a yellowish anal and femoral region.

The meristic data of the holotype, which shows the characteristic pattern, are given in table 13.

The female paratype (Geck 81 SC) contains two well developed eggs.

Earlier references to this species may be included under the name *Phelsuma abbotti.*

6. **Phelsuma sundbergi**

This green *Neophelsuma* species is found on the Praslin Bank of the Seychelles and on Marie Louise of the Amirante Islands (cf. Cheke 1982, in press). It is distinguished from other species by the following characters: Large size (-8 cm SVL), wider snout angle (cf. Cheke 1982) keeled chest scales, and unique pattern: Besides a dark streak from the nostril to the eye there usually is a shaped pre- and interocular figure on the head; the distinct dark red mottling on the posterior dorsum and sacrum consists of small longitudinal spots (-2.0 mm wide), which may have fused transversally and longitudinally to form a red network; chin and throat may turn yellowish and show an outer dark, eventually broken semicircle and a few irregular spots in this figure;

TABLE 15

Phelsuma sundbergi, FELICITE

specimen BSRC Geck	28 SC	33 SC	45 SC	47 SC	variation
sex	♀	♂	♀	♀	
SVL	54	65	67	61	54 –67
TL	"57"	"81"	"84"	"58"	—
SVL/TL	—	—	—	—	—
LH	13.4	15.5	16.4	14.7	13.4 –16.4
RE	7.0	8.4	8.8	7.5	7.0 – 8.8
NE	6.0	7.0	7.3	6.3	6.0 – 7.3
WH	8.5	10.6	11.6	9.5	8.5 –11.6
HH	5.5	7.0	8.0	6.3	5.5 – 8.0
LH/RE	1.9	1.84	1.86	1.96	1.84– 1.96
LH/NE	2.2	2.21	2.25	2.33	2.2 – 2.33
LH/WH	1.6	1.46	1.41	1.55	1.41– 1.6
LH/HH	2.4	2.21	2.05	2.33	2.05– 2.4
WH/HH	1.5	1.51	1.41	1.51	1.41– 1.51
NE/HH	1.09	1	0.91	1	0.91– 1.09
gran.: H	0.4	0.7	0.6	0.6	0.4 – 0.7
N	0.1	0.2	0.2	0.25	0.1 – 0.25
D	0.2	0.3	0.3	0.2	0.2 – 0.3
L	0.4	0.6	0.5	0.5	0.4 – 0.6
V	0.5	0.8	0.8	0.6	0.5 – 0.8
G	0.2	0.3	0.3	0.2	0.2 – 0.3
L/D	2	2	1.67	2.5	1.67– 2.5
H.1000/SVL	7.4	10.77	9.00	9.84	7.4 –10.77
N.1000/SVL	1.8	3.08	2.99	4.24	1.8 – 4.24
D.1000/SVL	3.7	3.69	4.48	3.28	3.28– 4.48
L.1000/SVL	7.4	9.23	7.46	8.20	7.4 – 9.23
V.1000/SVL	8.26	12.31	11.94	9.84	8.26–12.31
G.1000/SVL	3.7	3.69	4.48	3.28	3.28– 4.48
scales around midbody	86	88	82	76	76 –88
supralabials r/l	10/11	10/9	10/8	8/9	8 –11
sublabials r/l	9/8	8/7	9/7	7/8	7 – 9
lamellae 4th toe	23	29	25	26	23 –29
scansors 4th toe	13	16	15	13	13 –16
lamellae 4th finger	23	26	25	19	19 –26
scansors 4th finger	13	16	14	11	11 –16
preanal pores r/l	—	15/15	*c.* 15/15 p	*c.* 13/13 p	13 –15

femoral and anal region may turn yellowish or orange (especially in males), while the usual ventral colour is an indistinct white; legs are mottled with a slightly darker greyish or brownish green.

Our specimens, also living ones, were collected on Praslin, La Digue and Félicité and show the following geographic variation (for biometric data see tables 14-17):

The specimens from Praslin are usually

TABLE 16A

Phelsuma sundbergi, LA DIGUE

specimen BSRC Geck	43 SC	44 SC	46 SC	71 SC	72 SC
sex	♀	♂	♂	♀	♂
SVL	62	66	77	68	65
TL	79	"82"	"72"	"80"	"44"
SVL/TL	1.27	—	—	—	—
LH	15.0	16.6	17.0	16.8	17.0
RE	8.2	9.0	8.8	10.0	9.7
NE	7.6	7.0	7.8	8.1	8.7
WH	9.3	10.5	12.1	11.7	11.0
HH	6.8	7.4	7.9	8.1	7.0
LH/RE	1.83	1.84	1.93	1.68	1.75
LH/NE	1.97	2.37	2.18	2.07	1.95
LH/WH	1.61	1.58	1.40	1.44	1.55
LH/HH	2.21	2.24	2.15	2.1	2.43
WH/HH	1.37	1.42	1.53	1.46	1.57
NE/HH	1.12	0.95	0.99	1.01	1.24
gran.: H	0.6	0.5	0.6	0.7	0.8
N	0.2	0.2	0.3	0.2	0.25
D	0.3	0.2	0.4	0.3	0.35
L	0.4	0.4	0.45	0.5	0.5
V	0.7	0.8	0.9	0.7	1.0
G	0.25	0.3	0.3	0.2	0.3
L/D	1.33	2	1.13	1.67	1.43
H.1000/SVL	9.68	7.58	7.79	10.29	12.31
N.1000/SVL	3.23	3.03	3.90	2.94	3.85
D.1000/SVL	4.84	3.03	5.19	4.41	5.38
L.1000/SVL	6.45	6.06	5.84	7.35	7.69
V.1000/SVL	11.29	12.12	11.69	10.29	15.38
G.1000/SVL	4.03	4.54	3.90	2.94	4.62
scales around midbody	96	90	88	92	90
supralabials r/l	10/11	10	9	9/10	10
sublabials r/l	8/9	8/7	8/7	7/8	7
lamellae 4th toe	21	27	23	31	27
scansors 4th toe	10	14	12	18	14
lamellae 4th finger	21	23	19	25	25
scansors 4th finger	11	12	11	17	15
preanal pores r/l	—	13/14	10/11	—	16/

larger than those from the other islands. They show a lighter green dorsally, a lighter ventral coloration (white or slight yellowish) and a reduced pattern on the throat with fewer and less distinct markings.

On the contrary the specimens from La Digue and Félicité are usually smaller, and show a darker green dorsally, a darker ventral coloration (dark yellow or orange) and a broad dark pattern on the throat. The speci-

TABLE 16 B

Phelsuma sundbergi

specimen BSRC Geck	La Digue 73 SC	La Digue 74 SC	La Digue variation	La Digue or Félicité 27 SC
sex	♂	♀	—	♀
SVL	61	75	62 –77	63
TL	78	"78"	78 –79	"71"
SVL/TL	1.28	—	1.27– 1.28	—
LH	16.6	19.9	15.0 –19.9	15.2
RE	9.7	11.5	8.2 –11.5	8.4
NE	7.7	9.5	7.0 – 9.5	7.1
WH	11.4	15.2	9.3 –15.2	9.8
HH	7.0	9.3	6.8 – 9.3	7.3
LH/RE	1.71	1.73	1.71– 1.93	1.81
LH/NE	2.16	2.09	1.95– 2.37	2.14
LH/WH	1.46	1.31	1.31– 1.61	1.55
LH/HH	2.37	2.14	2.1 – 2.43	2.08
WH/HH	1.63	1.63	1.37– 1.65	1.34
NE/HH	1.39	1.02	0.95– 1.39	0.97
gran.: H	0.5	0.9	0.5 – 0.9	0.6
N	0.15	0.3	0.15– 0.3	0.2
D	0.3	0.4	0.2 – 0.4	0.2
L	0.5	0.6	0.4 – 0.6	0.4
V	0.6	1.0	0.6 – 1.0	0.8
G	0.15	0.3	0.15– 0.3	0.3
L/D	1.67	1.5	1.13– 2.0	2
H.1000/SVL	8.20	12	7.58–12.31	9.5
N.1000/SVL	2.46	4	2.46– 4	3.2
D.1000/SVL	4.92	5.3	3.03– 5.38	3.2
L.1000/SVL	8.20	8	5.84– 8.2	5.3
V.1000/SVL	9.84	13.3	9.84–15.38	12.7
G.1000/SVL	2.64	4	2.64– 4.62	4.8
scales around midbody	100	98	88 –100	90
supralabials r/l	9	8/9	8 –10	9
sublabials r/l	7	7	7 – 9	9/8
lamellae 4th toe	31	29	21 –31	26
scansors 4th toe	16	16	10 –18	13
lamellae 4th finger	25	19	19 –25	23
scansors 4th finger	15	10	10 –17	13
preanal pores r/l	p	—	10 –16/	—

mens from La Digue and Félicité do not differ from each other in coloration, but perhaps the specimens from Félicité are smaller on the average than those from La Digue. The two populations may be fairly easily separated by the number of scales around midbody, which is less than 88 for Félicité and more than 88 for La Digue. By the number of scales around

TABLES 17, 18

	P. sundbergi, PRASLIN	*P. mad. kochi*, MAJUNGA
specimen BSRC Geck	8 SC	7 SC
sex	♂	♂
SVL	74	65
TL	80	69
SVL/TL	1.19	1.06
LH	18.2	16.8
RE	9.9	9.5
NE	8.2	8.0
WH	12.4	10.8
HH	8.5	7.4
LH/RE	1.84	1.77
LH/NE	2.22	2.1
LH/WH	1.47	1.56
LH/HH	2.14	2.27
WH/HH	1.46	1.46
NE/HH	0.96	1.19
gran.: H	1.0	0.6
N	0.3	0.2
D	0.3	0.4
L	0.5	0.4
V	1.0	0.7
G	0.3	0.1
L/D	1.67	1
H.1000/SVL	13.51	9.23
N.1000/SVL	4.05	6.15
D.1000/SVL	4.05	6.15
L.1000/SVL	6.76	7.69
V.1000/SVL	13.51	10.77
G.1000/SVL	4.05	1.54
scales around midbody	88	86
supralabials r/l	10/11	10
sublabials r/l	8	8/9
lamellae 4th toe	22	25
scansors 4th toe	11	14
lamellae 4th finger	—	20
scansors 4th finger	13	12
preanal pores r/l	—	14/13

midbody, the Praslin animals can be separated neither from the La Digue nor from the Félicité animals.

At present we do not think it appropriate to distinguish subspecies in *Phelsuma sundbergi*, and therefore we place the name *Phelsuma madagascariensis (sundbergi) ladiguensis* Böhme & Meier 1982 into the synonymy of *Phelsuma sundbergi* (the availability of the name is doubtful in respect of Artt. 5, 6, 10 lit. b, 11 lit. c International Rules for Zoological Nomenclature; this question is definitely left open).

7. **Phelsuma madagascariensis**

This species shows considerable variation in its range, as is demonstrated by our specimens (cf. tables 18, 19). They seem to stem from different localities.

BSRC Geck 7 SC is from Majunga and must be referred to *Phelsuma madagascariensis kochi* on the basis of its coloration, pattern and biometric data; the same is true for a living specimen.

BSRC Geck 8, 13 MC are both *Phelsuma madagascariensis grandis.* The specimens belong to the series of several generations bred by the senior author and agree with the variation known for that subspecies.

The other alcohol specimens should not be assessed to a subspecies, as we definitely think that the amount of subspecific and intrasubspecific variation is not yet reliably described. These non-assignable specimens are included to give an idea of the specific variation in *Phelsuma madagascariensis* (ex. *kochi*).

BIOGEOGRAPHY AND PHYLOGENY

Madagascar is the center of evolution of the genus *Phelsuma.* It has already been shown, that the subgenus *Phelsuma* (*Archaeophelsuma*) on the Mascarene Islands consists of old relict forms surviving on the ancient periphery of the generic distribution and that the forms of *Neophelsuma* found outside Madagascar are more recent invaders (Börner 1972). As it may be presumed that the rate of evolu-

TABLE 19

Phelsuma madagascariensis SSPP. (EXCL. *kochi*)

specimen BSRC Geck	8 MC	13 MC	53 MC	55 MC	56 MC	variation
sex	semiad., ♂ ?	iuv.	♀	♀	♂	—
SVL	79	31	102	83	83	31 –102
TL	"82"	30	113	"42"	101	30 –113
SVL/TL	—	0.97	1.11	—	1.22	0.97– 1.22
LH	21.4	9.6	23.2	21.8	25.5	9.6 –25.5
RE	13.3	5.3	13.6	12.6	14.7	5.3 –14.7
NE	10.7	4.4	11.5	10.6	12.0	4.4 –12.0
WH	14.5	7.2	16.0	17.0	17.8	7.2 –17.8
HH	10.3	4.3	9.6	12.0	12.3	4.3 –12.3
LH/RE	1.61	1.81	1.71	1.73	1.73	1.61– 1.81
LH/NE	2.0	2.18	2.02	2.05	2.13	2.0 – 2.18
LH/WH	1.48	1.33	1.45	1.28	1.43	1.28– 1.48
LH/HH	2.08	2.23	2.41	1.82	2.01	1.82– 2.41
WH/HH	1.41	1.67	1.67	1.42	1.45	1.41– 1.67
NE/HH	1.04	1.02	1.20	0.88	0.98	0.88– 1.20
gran.: H	0.7	—	0.7	0.5	0.8	0.5 – 0.8
N	0.3	—	0.5	0.4	0.5	0.3 – 0.5
D	0.6	—	0.6	0.4	0.5	0.4 – 0.6
L	1.0	—	1.7	1.3	1.0	1.0 – 1.7
V	1.5	—	1.4	0.8	1.0	0.8 – 1.5
G	0.4	—	0.6	0.4	0.5	0.4 – 0.6
L/D	1.67	—	3.40	4.33	2	1.67– 4.33
H.1000/SVL	8.86	—	6.86	5.02	9.64	5.02– 9.64
N.1000/SVL	3.80	—	4.90	4.82	6.02	3.80– 6.02
D.1000/SVL	7.59	—	4.90	3.61	6.02	3.61– 7.59
L.1000/SVL	12.66	—	16.67	15.66	12.05	12.05–16.67
V.1000/SVL	20.25	—	13.73	9.64	12.05	9.64–20.25
G.1000/SVL	5.06	—	5.88	4.82	6.02	4.82– 6.02
scales around midbody	82	—	92	86	84	82 –92
supralabials r/l	10	9/8	7/8	9	9/8	7 –10
sublabials r/l	8/7	7	8/7	7/8	8	7 – 8
lamellae 4th toe	28	—	21	18	20	18 –28
scansors 4th toe	16	15	17	13	14	13 –17
lamellae 4th finger	22	24	21	16	23	16 –24
scansors 4th finger	13	12	15	11	15	11 –15
preanal pores r/l	—	—	15/17 p	16/16 p	21/21	15 –21/

tion in the subgenus *Neophelsuma* and its species groups is nearly equal throughout the subgenus, it is possible to conclude that the extent of character deviation in a given taxon proves the duration of its separate evolution. On this scale the *Phelsuma astriata* ancestor, a form related to *Phelsuma lineata,* was the earliest arrival in the Seychelles; *Phelsuma astriata* is considered to form a species group of its own (Börner 1972). The *Phelsuma longinsulae*

TABLE 20

SYNOPTIC TABLE OF THE VARIATION OF ADULT SPECIMENS IN THE *Phelsuma madagascariensis* SPECIES GROUP

taxon	*madagascariensis kochi* (1)	*madagascariensis* ssp. (4) (excl. *kochi*)	*sundbergi* (13)
SVL	65	79 –10.2	54 –77
SVL/TL	1.06	1.11– 1.22	1.19– 1.28
LH/RE	1.77	1.61– 1.73	1.71– 1.96
LH/NE	2.1	2.0 – 2.13	1.95– 2.37
LH/WH	1.56	1.28– 1.48	1.31– 1.61
LH/HH	2.27	1.82– 2.41	2.05– 2.43
WH/HH	1.41	1.41– 1.67	1.37– 1.65
NE/HH	1.19	0.88– 1.20	0.91– 1.39
L/D	1	1.67– 4.33	1.13– 2.5
H.1000/SVL	9.23	5.02– 9.64	7.4 –13.51
N.1000/SVL	6.15	3.80– 6.02	1.8 – 4.24
D.1000/SVL	6.15	3.61– 7.59	3.03– 5.38
L.1000/SVL	7.69	12.05–16.67	5.3 – 9.23
V.1000/SVL	10.77	9.64–20.25	8.26–15.38
G.1000/SVL	1.54	4.82– 6.02	2.64– 4.8
scales around midbody	86	82 –92	76 –100
supralabials	10	8 –10	8 –11
sublabials	8/9	7 – 8	7 – 9
lamellae 4th toe	25	18 –28	21 –31
scansors 4th toe	14	13 –17	10 –18
lamellae 4th finger	20	16 –23	19 –26
scansors 4th finger	12	11 –15	10 –17
preanal pores	—	15 –21/	10 –16/

ancestors arrived next, the *Phelsuma sundbergi* ancestor last.

Phelsuma sundbergi is closest to *Phelsuma madagascariensis kochi;* the Praslin population, from which the La Digue and Félicité populations are derived, is hardly distinguishable from Malagasian *Phelsuma madagascariensis kochi.* The main differences are only the condition of the chest scales (usually keeled scales in *Phelsuma sundbergi,* unkeeled scales in *Phelsuma madagascariensis kochi*), the length of the tail (long v. short), the flank colour (green v. brownish green with eventual white spots), and the dorsal pattern (smaller elements in vermiculation v. red spots).

The other Malagasian forms of *Phelsuma madagascariensis* (ex. *kochi*) have intermediary lengths of tails and green flanks like *Phelsuma sundbergi.* These resemblances seem to be due to a convergent evolution, as there are so many differences between *Phelsuma sundbergi* and *Phelsuma madagascariensis* (ex. *kochi*): *Phelsuma sundbergi* is smaller, especially its La Digue and Félicité specimens; its head and scale proportions, especially the L/D ratio, are usually closer to *Phelsuma madagascariensis kochi* than to *Phelsuma madagascariensis* ssp.; *Phelsuma sundbergi* has a yellow orange belly colour, a dark chin pattern and dark red dorsal pattern elements, being closer to *Phelsuma*

TABLE 20 (*Contd.*)

taxon	*andamanensis* (3)	*longinsulae* spp (18) Seychelles	*l. menaiensis* (2)	*chekei* (3)	*befotakensis* (3)
SVL	42 –56	41 –57	58 –61	55 –60	44 –48
SVL/TL	1.09– 1.40	1.15– 1.31	—	0.94– 1.23	1.36– 1.46
LH/RE	1.73– 1.89	1.77– 1.94	1.81	1.79– 1.92	1.81– 1.86
LH/NE	2.04– 2.15	2.05– 2.44	2.08– 2.27	2.17– 2.23	2.12– 2.18
LH/WH	1.47– 1.6	1.43– 1.72	1.4 – 1.61	1.37– 1.64	1.33– 1.53
LH/HH	2.14– 2.42	2.18– 2.6	1.86– 2.42	1.99– 2.30	2.06– 2.34
WH/HH	1.42– 1.64	1.34– 1.64	1.325–1.5	1.45– 1.46	1.33– 1.53
NE/HH	1.05– 1.10	0.97– 1.1	0.89– 1.33	0.9 – 1.03	0.95– 1.10
L/D	1 – 2.5	1 – 2.5	1.33– 2	1.67– 2.33	1.25– 1.67
H.1000/SVL	6.25– 7.14	5.45–11.11	3.44– 5.56	6.67– 9.09	8.33–11.36
N.1000/SVL	2.08– 2.69	1.72– 3.64	1.72– 2.46	2.73– 3.45	3.125–5.25
D.1000/SVL	3.57– 5.21	1.92– 5.45	4.92– 5.17	5 – 5.45	6.25– 9.09
L.1000/SVL	4.76– 8.93	3.63– 9.62	6.89– 9.84	8.33–12.06	10.42–11.36
V.1000/SVL	11.46–12.5	7.27–14.81	11.48–13.79	13.33–14.54	10.42–18.13
G.1000/SVL	2.08– 6.25	1.79– 3.64	2.58– 3.28	1.67– 2.73	3.125–3.41
scales around midbody	80 –90	70 –98	88 –90	68 –72	74 –78
supralabials	9 –11	8 –12	8 – 9	6 – 9	6 – 9
sublabials	8 –10	7 – 9	7 – 8	7 – 9	6 – 8
lamellae 4th toe	21 –24	20 –30	21 –22	21 –23	20 –22
scansors 4th toe	10 –15	10 –18	12 –13	10 –12	10 –13
lamellae 4th finger	18 –22	17 –23	18 –19	19	18 –22
scansors 4th finger	10 –14	9 –14	11	10 –11	10 –12
preanal pores	13 –16/	6 –16/	11 –15/	12 –17/	10 –17/

madagascariensis kochi than to *Phelsuma madagascariensis* ssp. in these elements, too. Finally, the pattern on the temple, which is a continuation of the chin and throat pattern, is almost as pronounced in *Phelsuma sundbergi* as in *Phelsuma madagascariensis kochi,* while it is much less distinct (faded or reddish instead of grey/black) or even lacking in the *Phelsuma madagascariensis* ssp.

Because of its smaller size, its dark spotted flanks, dark (even bluish) green dorsal colour and brick red pattern elements, its yellow anal region, its chin pattern, its short tail and short snout, and its scarcely enlarged laterals (L/D ratio), *Phelsuma madagascariensis kochi* should be considered as the most primitive member of the subgroup of large (6 cm SVL +) green forms, whose reduced dorsal patterns show transversal tendencies, the *Phelsuma madagascariensis* subgroup.

These above-mentioned characters of *Phelsuma madagascariensis kochi* are usually even more pronounced in the subgroup of small (-6 cm SVL) dark forms, whose extent dorsal patterns show longitudinal tendencies, the *Phelsuma abbotti* subgroup.

Therefore, *Phelsuma madagascariensis kochi* represents a phenotype derived from the taxon constituting the linkage between the two subgroups. *Phelsuma madagascariensis kochi* may

well represent a species of its own, but the final evaluation of its status must be the result of an extensive study of the total variation of *Phelsuma madagascariensis* in Madagascar.

Phelsuma madagascariensis (ex. *kochi*) and *Phelsuma sundbergi* reflect a parallel evolution from that ancestor in tail length, snout length, differentiation of laterals from dorsals and flank colour, and in the yellow factor (which brightens colour and pattern on the dorsum) though achieving different degrees of evolution in these characters. These two species reflect a divergent evolution from the ancestor in SVL (tendency towards a smaller size in *Phelsuma sundbergi* and towards a larger size in *Phelsuma madagascariensis*) and ventral colour and pattern (pronounced chin pattern and pronounced anal coloration in *Phelsuma madagascariensis*).

The phylogeny of the *Phelsuma abbotti* subgroup is even more complicated, but it is revealed by the character divergence of the forms, their geographic location and contemporary thinking on probabilities and chances of dispersal. In our opinion the clue to the phylogeny are the forms occurring on the Seychelles.

On the outer islands North and Silhouette and to a lesser extent on Frigate there are slender small geckos (*c.* 5 cm SVL) with a long head, a smooth transition from the small dorsals to the slightly enlarged laterals (L/D = *c.* 1-2) and few differentiated scales (labials, scansors, preanal pores). These characters are shared by the northwest Malagasian *Phelsuma befotakensis* as well as by *Phelsuma v-nigra* (including *Phelsuma robertmertensi*) from the Comoro Islands and also by *Phelsuma abbotti* from Aldabra. These forms primarily differ in their dorsal body pattern:

The forms from North and Silhouette Islands (*Phelsuma longinsulae rubra* resp. *umbrae*) and to a certain extent those from Frigate (*Phelsuma longinsulae longinsulae*) are bright green dorsally and have bright red dorsal marks. The forms from the Comoro Islands and *Phelsuma befotakensis* may assume a similar dorsal coloration, but usually show a bluish hue or are distinctly bluish. In this dark phase, the dorsal pattern is dark redbrown and the flanks may be dark grey-blue. The dorsal and lateral ocelli of *Phelsuma befotakensis* are greyish in the dark phase and yellowish in the light phase.

This survey of the dorsal colours demonstrates that the Malagasian *Phelsuma befotakensis* here retains the most primitive trait. Its ancestor gave rise to the Comoro forms, which are quite close : The yellow ocelli (which are arranged in longitudinal rows and which partly may fuse to form stripes, especially a vertebral stripe) formed the red pattern, while the tendency to a predominantly bluish ground colour persisted. The forms from the outer Seychelles are more advanced, as they intensified the yellow tendency of the ground colour. The yellow ocelli of *Phelsuma befotakensis* turned red, this state of evolution being demonstrated by the geckos from North Island, the most outlying island; a similar evolution took place in the Comoro Islands. In a second stage of evolution the red markings have been reduced, as they are very conspicuous in foliage dwelling forms (cf. Borner 1980). This tendency is demonstrated by the forms occurring on North Island, Silhouette and Frigate; even their ontogeny shows the reduction of red pattern: When a specimen of these forms grows older, the red pattern concentrates on the mid-dorsum and sacrum. The present day *Phelsuma befotakensis* also shows a modern trait, as its laterals (L/D ratio) are now enlarged a little more than those of the peripheral forms on the Comoro Islands and northern

Seychelles, a fact confirming the idea that the evolution is fastest in the center and slowest on the periphery of the range of the taxon.

Phelsuma abbotti from Aldabra Island is also considered to belong to this group. This latter species shows dark red dorsal markings on a dull greyish green or bluish grey dorsum and dark brown, nearly blackish flanks mottled with white spots; it has no ocelli on the flanks like *Phelsuma chekei*. This dark pattern serves to camouflage the trunk-base-dwelling gecko, of which Honegger reports that it lives sometimes in close association with the giant turtles, even taking refuge under their carapaces (cf. Blanc 1972, 591 referring to *Phelsuma barbouri* as a secondary ground dweller; the junior author has observed in Mauritius that *Phelsuma o. ornata* frequents the ground, too). So two explanations for this dark pattern are possible:

a) Either it represents a persisting trait of the ancestor to *Phelsuma befotakensis*; then the ancestor presumably had a darker coloration than *Phelsuma befotakensis*, which acquired its more bluish coloration and its capacity to show a "light", yellow phase after the colonization of Aldabra Island.

or

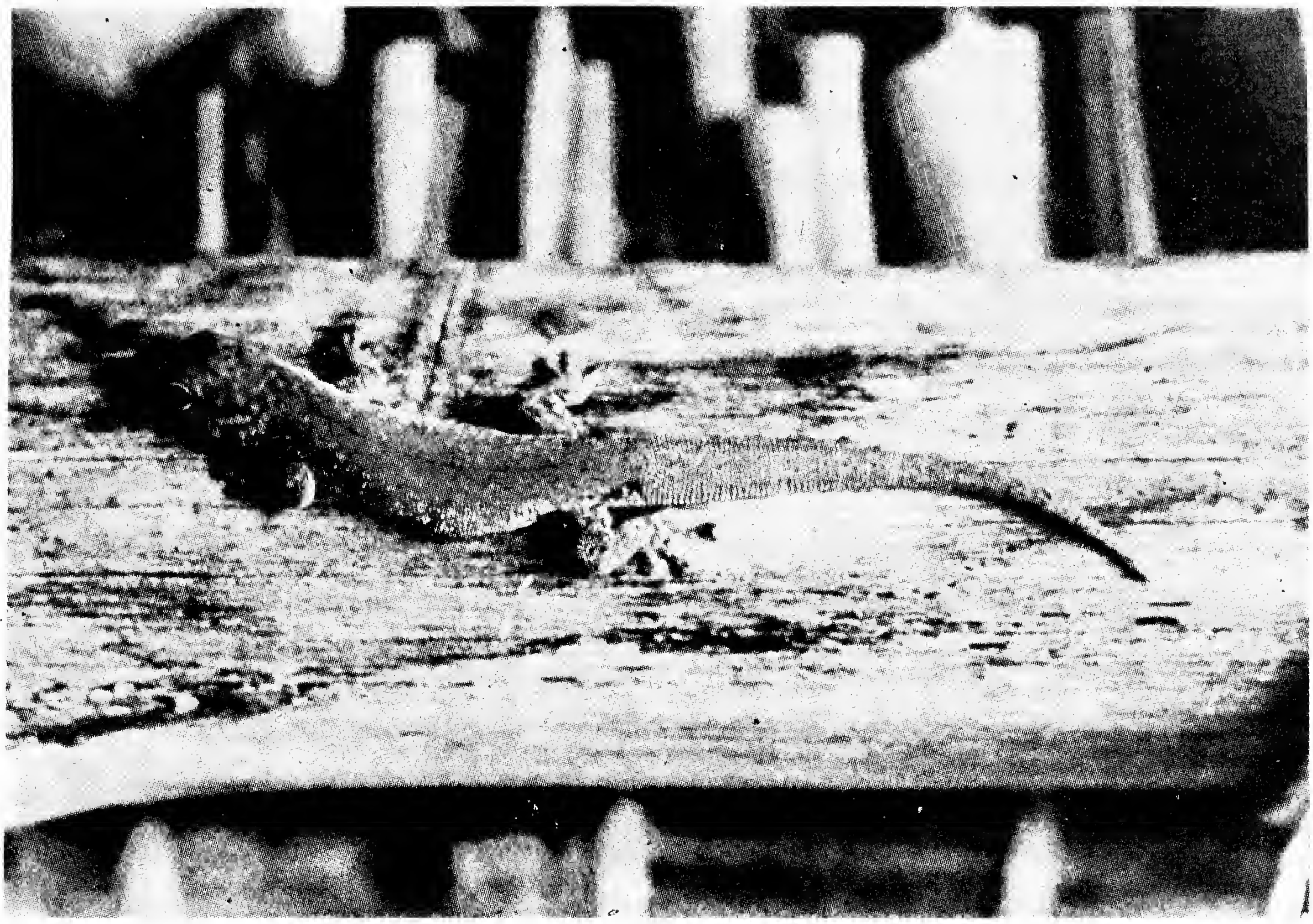
b) *Phelsuma abbotti* underwent a selection according to the specific conditions prevailing on Aldabra Island, and this selection has favoured a gecko "in its darkest phase".

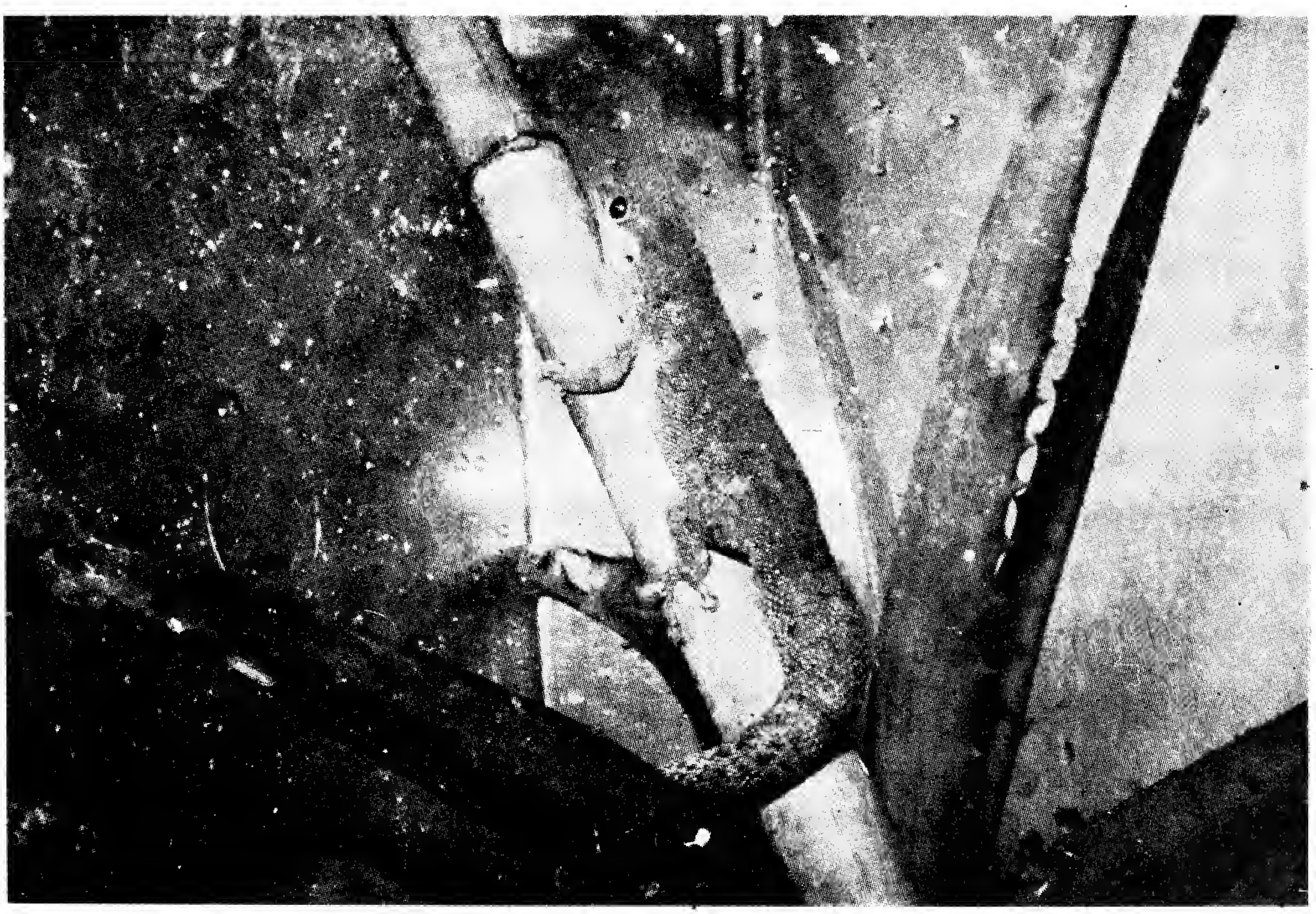
In our opinion none of these possible theories may be excluded, and both apply to explain the current situation: *Phelsuma abbotti* is an early off-shoot of the dark *Phelsuma befotakensis* ancestor, and subsequent selection favoured an even darker gecko. This theory is much more probable than the construction of an affinity with *Phelsuma chekei*. Both forms share only their dark colour, but they differ in proportions, scalation, and position of ocelli, which are characters of much greater consistency in island forms; *Phelsuma chekei* has ocelli on the flanks, but not *Phelsuma abbotti* (even true for juveniles), and *Phelsuma chekei* lacks any dorsal ocelli that may be related to the dark red ones of *Phelsuma abbotti;* juveniles of *Phelsuma abbotti* show a green dorsum earlier than those of *Phelsuma chekei*. Moreover, *Phelsuma abbotti* and *Phelsuma befotakensis* share the basic pattern (including the U-shaped stripe on the neck, the vertebral stripe, and the position of the ocelli, which are darker in *Phelsuma abbotti*).

The second assemblage in the *Phelsuma abbotti* subgroup is constituted by the large robust geckos (approx. 6 cm SVL) with a shorter head, a more abrupt transition from the small dorsals to the enlarged laterals (L/D: 1.5 - 2.5) and more differentiated scales (labials, scansors, preanal pores). These forms are found in North Madagascar (*Phelsuma chekei*), on Assumption Island (*Phelsuma sumptio*), on Menai Island, Cosmoledo Atoll (*Phelsuma longinsulae menaiensis*) and on Mahé, Seychelles (*Phelsuma longinsulae pulchra*).

They differ from each other mainly in dorsal coloration and pattern.

Phelsuma chekei has a greyish blue dorsum with dark red markings which may turn almost black in the dark phase, and a greyish pattern on the flanks. *Phelsuma sumptio* has a more bluish dorsum with faded dark red marks, the same vertebral stripe, and a reduced obscure mottling on the flanks; this may be described as "a concolorous type of *Phelsuma chekei*". But both forms differ in their ventral coloration (slightly yellowish in *Phelsuma chekei*, distinctly yellow or even orange in *Phelsuma sumptio*).





Above: P. abbotti; Aldabara Island. (*Photo*: P. Niedzwicki).
Below: P. sumptio; Assumption Island. (*Photo*: A.S. Cheke).

Table 21

Labials

		P. sundbergi	*P. madagascariensis*	*P. chekei*	*P. befotakensis*	*P. longinsulae*	*P. l. menaiensis*	*P. andamanensis*
Supralabials	6	0	0	1	1	0	0	0
	7	0	1	2	2	1	0	0
	8	3	3	2	1	6	2	2
	9	10	4	1	2	10	2	3
	10	10	4	0	0	6	0	1
	11	3	0	0	0	10	0	0
	12	0	0	0	0	0	0	0
	mean	9.5	8.9	7.5	7.7	9.5	8.5	8.8
Sublabials	6	0	1	0	1	1	0	0
	7	12	5	3	4	13	3	0
	8	10	5	2	1	15	1	2
	9	4	1	1	0	5	0	3
	10	0	0	0	0	0	0	1
	mean	6.7	7.5	7.7	7.0	7.7	7.3	8.8
difference between means		2.8	1.4	−0.2	0.7	1.8	1.2	0

Phelsuma longinsulae menaiensis and *Phelsuma longinsulae pulchra* are dull green dorsally and may show a bluish hue; their dorsal pattern is dull red. While *Phelsuma longinsulae menaiensis* usually shows some sort of dark and light flank mottling, this is usually lacking in *Phelsuma longinsulae pulchra.* Both forms also differ meristically.

Phelsuma longinsulae longinsulae is truly intermediate between the Mahé form *pulchra* and the northern forms *umbrae* and *rubra.* This situation is best explained by secondary intergradation: First the *Phelsuma befotakensis* — derivate arrived on the Seychelles and colonized all islands. Later in a second invasion the *Phelsuma chekei* — derivate arrived on Mahé where it interbred with the earlier arrivals. Some *Phelsuma chekei* — derivates or — more probably — some Mahé lizards of the combined type came to Frigate and influenced that gene-pool. The bright green colour and the intensive red markings stemming from the *Phelsuma befotakensis*-derivates turned duller under the influence of the bluish/black-red trend inherited from the *Phelsuma chekei*-derivates. The slender proportions of the early invaders turned more robust, and the primitive undifferentiated scalation of the early invaders turned to a more advanced state under the influence of the later arrivals. Therefore, the Mahé lizards now show characters intermediate between those of the forms from the northern islands and those of northern Malagasy, and the Frigate form is intermediary in the even smaller gap between the Mahé geckos and those from the northern islands. That a similar intergradation took place on tiny Menai Island is very improbable. We think it more probable that Menai was colonised by the new type from Mahé. This theory would be in

line with the close relation between the Mahé lizards and the Menai ones, with the fact that the Menai gecko shows an advanced scalation in comparison to the (parental) Mahé gecko and with the parallel case observed in *Phelsuma astriata*: *Phelsuma astriata* is found on the Seychelles and — in a derived form — on the tiny Astove Island (close to Menai Island), the latter form lacking **a** close relative on Madagascar.

This theory of two invasions of the Indian Ocean, meeting finally in the Seychelles, is in line with the evaluation of the two parental mainland forms *Phelsuma befotakensis* and *Phelsuma chekei* as species. In fact the basic structure of their patterns and their bluish dorsal ground colour (in *Phelsuma befotakensis* in the dark phase only) could be arguments for conspecificity, but on the other hand there are great differences in proportions, scalation and actual coloration and pattern, and these differences are more pronounced than those usually found in any two sibling species of a species group of this genus. Furthermore, our theory would explain the existence of the two pheno-types in the *Phelsuma abbotti*-subgroup.

This taxonomic assessment is in accordance with the species concept outlined by the junior author (Börner 1976/1982).

Another problem not yet discussed is the relation of *Phelsuma andamanensis*. Its position in the *Phelsuma madagascariensis* species group (Loveridge 1942, Mertens, Blanc 1972) has never been doubted. Its biometric data and the quality of its coloration and pattern clearly belong to the variation shown by the other forms of this species group, but *Phelsuma andamanensis* differs from all other members of the species group by the lack of enlarged postmentals.

Phelsuma andamanensis does not belong to the *Phelsuma madagascariensis* subgroup. Though its biometric data usually are in conformity with those of *Phelsuma sundbergi* and though especially the forms from La Digue and Félicité are similar in size and in ventral coloration, *Phelsuma andamanensis* lacks the wide head angle and the keeled chest scales of that species. The keeled chest scales are considered an advanced character and should therefore be present in a derived form, as should be the distinctive head angle. *Phelsuma madagascariensis* differs by size, shape and scalation (advanced state of laterals and preanal pores in *Phelsuma madagascariensis*). Both, *Phelsuma sundbergi* and *Phelsuma madagascariensis* (incl. *kochi*) tend to reduce the red pattern to the sacral region, and both (ex. *kochi*) show red patterns with a distinct tendency towards a transversal arrangement. In contrast to these tendencies *Phelsuma andamanensis* has a red neck pattern and an irregularly longitudinally arranged pattern on the posterior dorsum.

Phelsuma andamanensis is closer to the *Phelsuma abbotti* subgroup, in which the longitudinally arranged dorsal pattern prevails. Within this subgroup, *Phelsuma andamanensis* is nearest to the forms occurring on the islands Silhouette, North and Frigate. *Phelsuma andamanensis* seems to originate from the first Seychelles invader: The ancestor species of *Phelsuma befotakensis* increased its size, the number of scales (except preanal pores, see below), and the yellow factor in the ground colour and pattern. The conspicuous neck stripes of *Phelsuma andamanensis* are similarly pronounced in the types of the North Island form (*Phelsuma longinsulae rubra*) where they are part of the longitudinally fused rows of red blotches, and they may sometimes be seen in other Seychelles specimens as well. The back pattern of *Phelsuma andamanensis* (except the neck stripes) is very similar

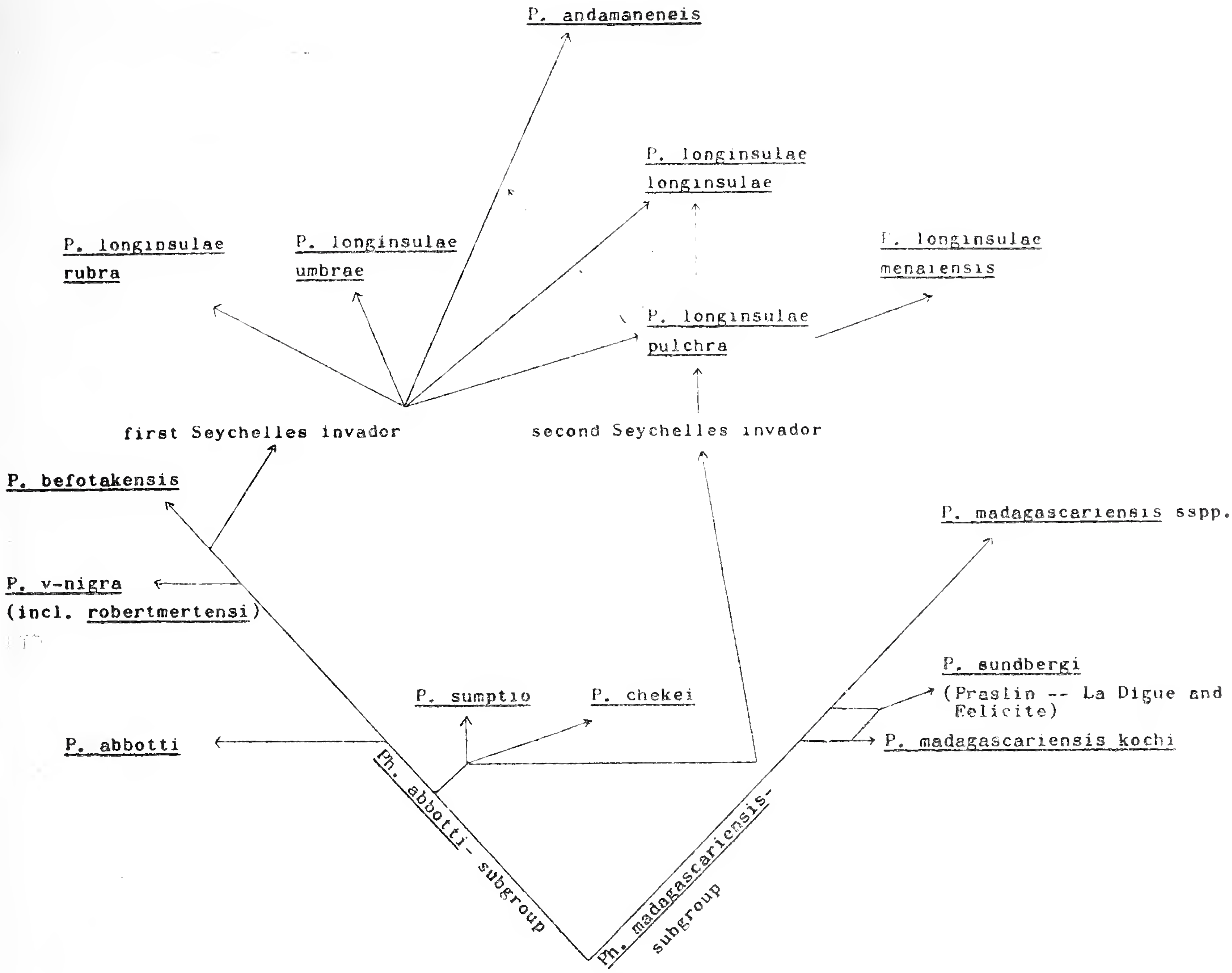


Fig. 2. Phylogenetic tree.

to that of the Silhouette form. The facts that in contrast to these Seychelles forms *Phelsuma andamanensis* has a more yellowish vent, contains concolorous specimens and has no reduced number of preanal pores, may be explained by the long isolation of *Phelsuma andamanensis*: It originated from an ancestor of the Seychelles forms of nowadays, and it underwent a separate evolution in a closed gene-pool during its isolation on the Andaman Islands.

Phelsuma chekei has a shorter tail, a stouter, more robust shape, a shorter fore head, and a coarser scutellation (except the gulars) than *Phelsuma andamanensis.* Furthermore, *Phelsuma chekei* differs by its prominent blue factor in colour and pattern and its different chin and lateral head pattern. *Phelsuma chekei* is a more recent invader of the Indian Ocean; before it spread to the Seychelles it would have had to travel more than 5600 km NE from the north tip of Madagascar to the Andaman Is-

lands, whereas the early Seychelles colonizer had to cross only 4500 km ENE, favoured by an ocean current in the same direction.

The theory of the phylogeny of the *Phelsuma madagascariensis* species group developed in this discussion is reflected by the phylogenetic tree shown in Figure 2.

Phelsuma parkeri from Pemba is not assessed here. Its uniform green dorsal coloration and its immaculate white colour underneath as well as its rather large size (-7.0 cm SVL) are arguments for placing it in the *Phelsuma madagascariensis* subgroup. Its pholidosis, as far as it is reported, lies within the variation of the subgroup. In general, its shape seems to be quite similar to that of *Phelsuma sundbergi* from the outer islands. A relation to *Phelsuma befotakensis* and the Comoro species seems to be not so probable, as *Phelsuma parkeri* shows no tendency to an ocellated pattern with red and is too large. *Phelsuma chekei* and related forms have the primitive chin pattern, of which *Phelsuma parkeri* shows no trace.

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Additional remarks

Cheke (in litt. 1983) has drawn our attention to the fact that due to an unfortunate muddling of the labels during shipment the locality data of his specimens from the Seychelles are not sufficiently reliable to base new names on them. Of course, our method of assessing the specimens implies a certain uniformity of characters in each island population. Nevertheless, some of his specimens have good data, and there is some reason in our method, so that we maintain our opinion. Cheke (in litt. 1983) does not follow our opinion to separate *Phelsuma longinsulae rubra* from *Phelsuma longinsulae longinsulae*, as he sees no difference between these forms. He has kindly sent us field drawings of two hatchlings, which differ in juvenile coloration: The hatchling from North Island (our subspecies *rubra*) shows three (reddish) stripes on the dorsum (except anterior dorsum where only the vertebral stripe is continued), while the hatchling from Frigate (our subspecies *longinsulae*) lacks the dorsolateral stripes and instead shows an accumulation of small red spots on the posterior dorsum. Further observations will show, whether this difference is due to individual variation.

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AGASTYAMALAI AND ITS ENVIRONS: A POTENTIAL AREA FOR A BIOSPHERE RESERVE[1]

A. N. Henry, M. Chandrabose,
M. S. Swaminathan and N. C. Nair[2]

(*With a text-figure*)

Agastyamalai, a towering peak of 1868 m in the tail-end of the Western Ghats and the adjoining forests in Tirunelveli and Kanniyakumari district of Tamil Nadu, and Trivandrum district of Kerala, covering a total area of about 2000 sq. km. and skirting the peak, form the most diverse and unknown ecosystem in Peninsular India. This area has substantial natural vegetation cover ranging from Scrub forests to Wet evergreen (rain forest) formations. Since Tropical rain forest is entering a period of rapid decline as a world natural resource, Agastyamalai must be regarded as a prime example of this ecosystem in Southern India. Further, the complexity and diversity of flora make it an ideal genepool sanctuary. This area also harbours a number of endemic species of plants that are unique to Peninsular India. In terms of uniqueness, number of endemics, endangered species, floral and faunal representations and the ease of protection, this pocket is an ideal choice for a biosphere reserve.

Introduction

The attempt to set up a world-wide network of biosphere reserves is a new and important initiative undertaken by the UN- sponsored 'Man and Biosphere' Programme to provide an assured future for mankind. The emphasis of the programme is on the relationship between man and nature. To be successful, it must preserve areas of undisturbed nature as genetic reservoirs and as standards against which change outside can be measured and judged. So far 40 nations have set apart 161 such reserves. In India, the Advisory Committee of the 'Man and Biosphere' Programme, has identified so far twelve biosphere reserves and has decided to set up two of these, namely the Nilgiri and the Namdapha in the first instance. This paper highlights the potentiality of another site in southern India namely "Agastyamalai and its environs" which would best fulfil the objectives of a biosphere reserve.

"The Western Ghats or Sahyadris and the West Coast sub-region" (also classified as "The Malabar Rain Forest Province") is perhaps the richest biogeographic province of the Indian subcontinent. The forest tracts of Agastyamalai and its environs including Mundanthurai, Kalakad, Mahendragiri, Muthukuzhivayal and Neyyar which are situated at the southern end of the Western Ghats still retain substantial natural vegetation cover. The vegetation occurs in large continuous tracts above 800 m, forming probably the finest remaining example of tropical wet evergreen forest (rain forest) in the Western Ghats. The field studies conducted in this region by the Botanical Survey of India and other agencies have revealed that all the essential criteria for

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[2] Botanical Survey of India, Coimbatore-641 003.

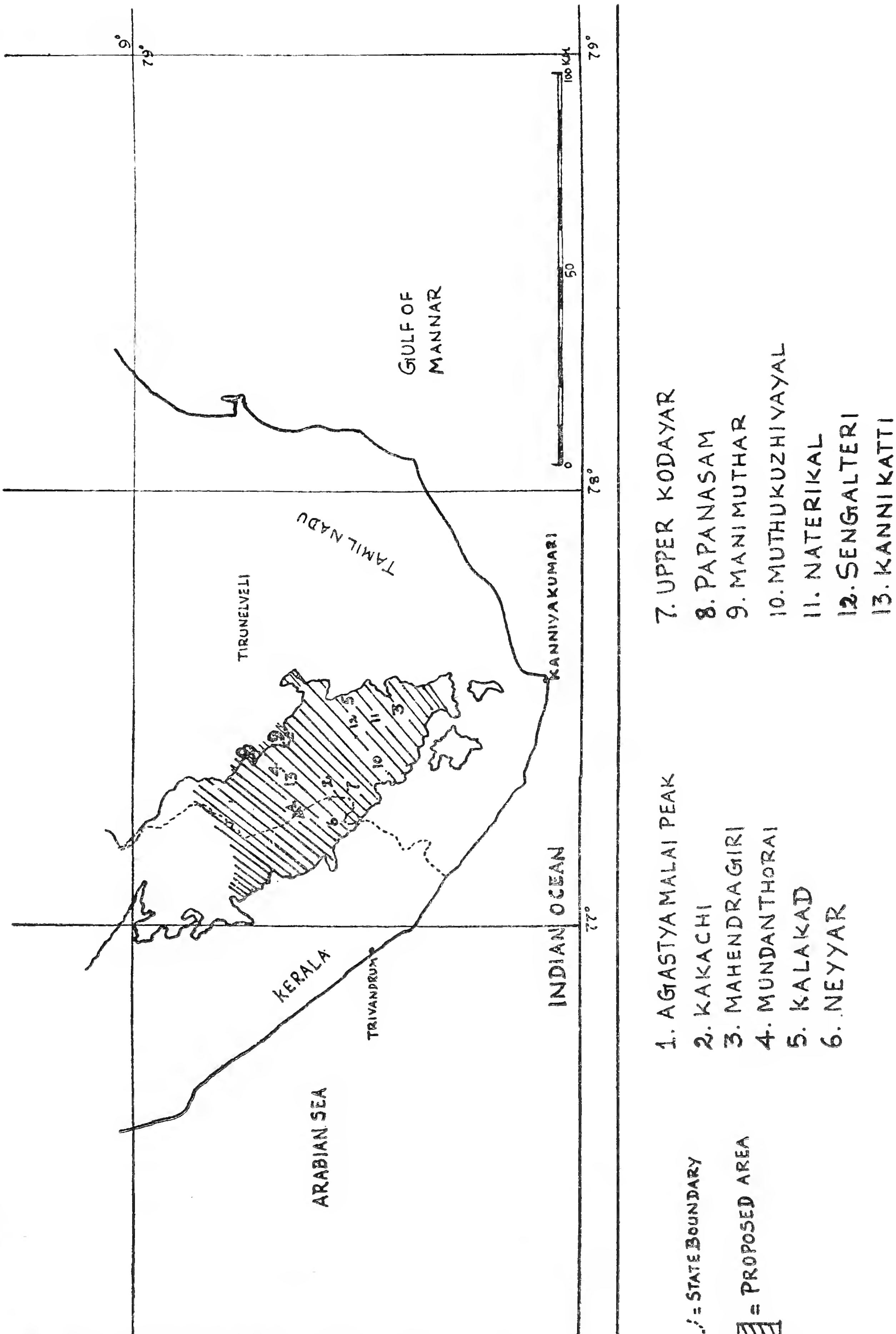

Fig. 1. Map showing the proposed area for the biosphere.

the choice of a biosphere reserve (UNESCO 1974) could be envisaged in these natural forests.

I. **Location:** The total area proposed for the biosphere reserve is approximately 2000 sq. km. and falls within the hilly tracts of Tirunelveli and Kanniyakumari districts of Tamil Nadu and Trivandrum district of Kerala, lying between 77° 5′ and 77° 40′E, and 8° 20′ and 8° 50′ N. (Fig. 1). The entire forest area is hilly, characterised by numerous folds and extensions engulfing small, narrow valleys. The altitude varies from 67 m to 1868 m. The conical Agastyamalai peak, locally known as "Pothikaimudi" and "Agasthiyarkudam" (1868 m) is the highest peak of the range. These hills form a very compact block comprising Papanasam R. F., Singampatti R. F., Kalakadu R. F., Kottur R. F., Kottur extension R. F., Mahendragiri R. F., Kalamalai R. F., Veerapuli R. F., Nattukkaltheri R. F. and Ashamboo R. F. This region is drained by several small perennial streams which join to form major river systems such as Tambaraparani, Neyyar, Karamanayar and Kodayar.

The South-West monsoon from June-September, and North-East monsoon in October and November bring rain to this region, and the annual rainfall varies at different places from 89 cm to 625.7 cm.

The hottest months of the year are April and May and the cold season prevails from December to February. The temperature varies between 21°C and 38°C.

The soils at low elevations consist of red ferruginous sandy loam of very little depth, with loose boulders. On hill slopes which are subjected to heavy wash the soil has a characteristic yellow or red colour. Over the crest and along the higher slopes of the hills where the erosion is excessive, the ground is rocky with the soil shallow and hard. In the wet evergreen forests, there is a rich collection of humus.

II. **Vegetation:** Since the ecosystem diversity is quite high, almost all vegetation types known from the Western Ghats occur in this region depending on the altitudinal zonation, such as Southern tropical thorn forest, Southern tropical dry deciduous forest, Grasslands at low altitudes, Southern tropical moist deciduous forest, Southern tropical wet evergreen forest, Subtropical montane forest and Grassy swards at high altitudes.

i. *Southern tropical thorn forest*: This type can be seen at an altitude of about 200 m and occurs around Papanasam, Kalakadu, Tirukurangudi, etc. In these scrub jungles trees like *Acacia chundra* (Roxb.) Willd., *A. horrida* (L.) Willd., *A. planifrons* Wight & Arn., *Euphorbia antiquorum* L., *Zizyphus oenoplia* (L.) Mill. and *Z. xylopyrus* (Retz.) Willd. are common. Amidst these trees, shrubs such as *Carissa carandas* L., *Dichrostachys cinerea* (L.) Wight & Arn., *Dodonaea viscosa* (L.) Jacq., *Securinega leucopyrus* (Willd.) Muell.-Arg. and *S. virosa* (Roxb. ex Willd.) Pax & Hoffm. are frequently met with. The climbers are represented by *Abrus precatorius* L., *Cissus quadrangularis* L., *Jasminum calophyllum* Wall., *Tylophora indica* (Burm. f.) Merrill, etc.

ii. *Southern tropical dry deciduous forest*: These forests occur at an altitude of about 350 m and are located in Kalakadu R. F., Papanasam R. F., Singampatti R. F. and Kottur R. F. The dominant trees in this type are *Adina cordifolia* (Roxb.) Hook. f. ex Brandis, *Anogeissus latifolia* (Roxb.) Bedd., *Dillenia pentagyna* Roxb., *Pterocarpus marsupium* Roxb., *Semecarpus anacardium* L.f. and *Terminalia chebula* (Gaertn.) Retz. Shrubs like *Acacia pennata* (L.) Willd., *Chassalia ophioxyloides* (Roxb.) Craib, *Desmodium triangulare* (Retz.) Merr. var. *congestum* (Wight &

Arn.) Sant. and *Phyllanthus polyphyllus* Willd. are found frequently. Some of the herbaceous species such as *Desmodium triflorum* (L.) DC., *Indigofera prostrata* Willd., *Oryza granulata* (Nees) Arn. ex Steud. and *Rostellularia pumila* Nees are common. Along rocky riversides, *Mangifera indica* L. is commonly met with.

iii. *Grasslands at lower altitudes*: At lower elevations below 500 m, vast stretches of grasslands occur beyond the scrub jungles and deciduous forests. Trees like *Mundulea sericea* (Willd.) A. Chaval and *Terminalia chebula* Retz. are seen sporadically in these grasslands. *Cymbopogon coloratus* (Nees) Stapf and *Themeda cymbaria* Hack. are the two dominant species of grasses occurring in this type. Amidst these, *Euphorbia cristata* Heyne ex Roth and *Rhynchosia rufescens* DC. are noticeable in the dry season.

iv. *Southern tropical moist deciduous forest*: This type of vegetation occurs at an altitude of about 500 m, and covers an extensive area in the proposed biosphere reserve. The forests are thick and densely populated with *Calamus* sp. The top canopy consists of trees such as *Acronychia pedunculata* (L.) Miq., *Dalbergia coromandeliana* Prain, *D. latifolia* Roxb., *Pterocarpus marsupium* Roxb., *Scleropyrum wallichianum* (Wight & Arn.) Arn., *Terminalia chebula* Retz., *T. paniculata* Roth and *Vateria indica* L. Some of the common shrubs found are *Barleria courtallica* Nees, *Blachia calycina* Benth., *Helicteres isora* L., *Ixora brachiata* Roxb., *Mussaenda laxa* (Hook. f.) Hutch. ex Gamble and *Psychotria connata* Wall. *Butea parviflora* Roxb. and *Gnetum ula* Brongn. are the conspicuous lianas met with. The notable climbers are *Calycopteris floribunda* (Roxb.) Poir., *Cynanchum tunicatum* (Retz.) Alston, *Dioscorea oppositifolia* L., *Jasminum rottlerianum* Wall. ex DC., *Maerua oblongifolia* (Forsk.) A. Rich. and *Sarcostigma kleinii* Wight & Arn. Some of the common herbs forming the undergrowth are *Alysicarpus rugosus* (Willd.) DC., *Justicia betonica* L. and *Waltheria indica* L. *Musa superba* Roxb. also occurs in this region.

v. *Southern tropical wet evergreen forest*: These forests occur roughly between 760 m and 1500 m and are located around Mahendragiri peak, Agastyamalai peak, Muthukuzhivayal, Naterikal to Sengaltheri, Upper Kodayar and Athiramalai. Though some of these areas are a little disturbed by road formations, irrigation schemes, hydro-electric projects, etc., most of the areas especially around Agastyamalai peak are undisturbed. The top canopy is extremely dense represented by gigantic trees like *Artocarpus hirsutus* Lam., *Canarium strictum* Roxb., *Cullenia exarillata* Robyns, *Diospyros ebenum* Koen. ex Retz., *Elaeocarpus tuberculatus* Roxb., *Hopea utilis* (Bedd.) Bole and *Palaquium ellipticum* (Dalz.) Baill.

Under these large trees, medium-sized trees which love more shade, form a second storey. Some of the dominant trees in this layer are *Cinnamomum iners* Reinw., *Decussocarpus wallichianus* (Presl) De Lauben., *Eugenia mundagam* Bourd., *Garcinia echinocarpa* Thw. var. *monticola* Mahesh. and *Kingiodendron pinnatum* (Roxb. ex DC.) Harms.

Under this second layer, innumerable shrubs or small trees such as *Agrostistachys indica* Dalz., *Antidesma menasu* Miq. ex Muell.-Arg., *Callicarpa tomentosa* (L.) Murray, *Elaeocarpus munroii* (Wight) Mast., *Eurya nitida* Korth., *Litsea deccanensis* Gamble, *Mallotus distans* Muell.-Arg. and *Tabernaemontana gamblei* Subr. & Henry occur.

Climbers like *Ancistrocladus heyneanus* Wall. ex Graham, *Aristolochia indica* L., *Piper barberi* Gamble, *P. nigrum* L., *Pothos scandens* L. and *Senecio walkeri* Arn. clothe

the large tree trunks, shrubs and small trees.

The following herbs and undershrubs form the ground layer: *Acranthera grandiflora* Bedd., *Apama barberi* Gamble, *Begonia malabarica* Lamk., *Carex filicina* Nees ex Wight, *Elatostema lineolatum* Wight, *Ophiorrhiza eriantha* Wight, *Psychotria curviflora* Wall., *Saproma corymbosum* (Bedd.) Bedd. and *Sarcandra grandifolia* (Miq.) Subr. & Henry are some of the dominant species.

Wild variety of *Elettaria cardamomum* (Roxb.) Maton is seen in some patches. Amongst these moist evergreen forests, dense tracts of *Ochlandra travancorica* (Bedd.) Benth. ex Gamble and *Schumannianthus virgatus* (Roxb.) Rolfe occur extensively, often to the exclusion of all other vegetation.

Epiphytic orchids like *Coelogyne nervosa* A. Rich., *Dendrobium wightii* Hawkes & Heller, *Oberonia brunoniana* Wight and *Sirhookera latifolia* (Wight) O. Kuntze, are commonly seen on tree trunks.

Some of the common ferns are *Angiopteris evecta* (Forst.) Hoffm., *Arachnoides aristata* (Forst.f.) Tindale, *Asplenium tenuifolium* Don, *Cyathea gigantea* (Wall. ex Hook.) Holttum and *Marattia fraxinea* Sm.

vi. *Subtropical montane forest*: There are very few tracts of montane forest remaining in the Western Ghats that can match the Agastyamalai area for its richness of flora and fauna. This type occurs as continuous expanse of the evergreen forests generally above 1500 m around Agastyamalai peak, Mahendragiri peak and Kakachi. The sheltered faces and moist depressions of peaks offer a foothold for these types of forests where the trees are of stunted nature due to the high velocity of wind and high altitude. The height of trees rarely exceeds 6 m, and are densely clothed with lichens, mosses, ferns and orchids. Some of the dominant species are *Byrsophyllum tetrandrum* (Bedd.) Hook. f. ex Bedd., *Canthium neilgherrense* Wight, *Eugenia mabaeoides* Wight, *Euphorbia santapaui* Henry, *Hedyotis purpurascens* Hook. f., *Impatiens leschenaultii* (DC.) Wall. ex Wight & Arn., *Lasianthus blumeanus* Wight, *L. cinereus* Gamble, *Ligustrum decaisnei* Clarke, *Moonia heterophylla* Arn. and *Polyscias acuminata* (Wight) Seem.

vii. *Grasslands at high altitudes*: Grassy swards are seen in smaller dimensions on the exposed rocky surfaces at high altitudes especially around Agastyamalai peak, Mahendragiri peak, Muthukuzhivayal and Kakachi. Some of the common grasses met with are *Arundinella purpurea* Hochst. ex Steud. var. *laxa* Bor, *Chrysopogon orientalis* (Desv.) Camus, *Eulalia phaeothrix* (Hack.) O. Kuntze, *Isachne walkeri* (Arn. ex Steud.) Wight & Arn. ex Thw., *Themeda tremula* (Nees ex Steud.) Hack. and *Zenkeria sebastinei* Henry & Chandr. An interesting herbaceous member of the Dilleniaceae — *Acrotrema arnottianum* Wight, and other herbs like *Centratherum rangacharii* Gamble, *Exacum travancoricum* Bedd., *Heracleum candolleanum* (Wight & Arn.) Gamble, *Leucas vestita* Benth. and *Smithia blanda* Wall. ex Wight & Arn. are frequently met with.

III. **Fauna**: This region is rich in various species of invertebrates, birds, reptiles and mammals. It harbours good populations of such endangered species as the Indian Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Tiger (*Leo tigris*), Leopard or Panther (*Leo pardus*), Nilgiri Langur (*Presbytis johni*), and notably a good population of the endangered lion-tailed macaque (*Macaca silenus*). Its bird fauna is particularly rich.

IV. **Landscape**: This region provides one of the most magnificent mountain landscapes including the valleys, peaks and mountains

with inaccessible steep rocky slopes covered with dense forests.

V. **Zones of the biosphere reserve:** The landscape in general, aids for the organisation of a generalised biosphere reserve wherein all the components making up the reserve are contiguous. The forest tracts encircling the conical Agastyamalai Peak comprise Montane forests, Grassy Swards and dense evergreen forests which are primary and undisturbed due to their occurrence in difficult terrain and steep inhospitable slopes, and these are to be designated as the "Core or Natural Zone" of the biosphere reserve. Around this core zone there are large tracts of little disturbed evergreen forests and most deciduous forests (in and around Kannikatti, Athiramalai, Bonaccord, Upper Kodayar, Muthukuzhivayal, Manjolai, Kakachi, Sengaltheri to Naterikal), and dry deciduous forests (Mundanthurai, Neyyar, Lower Kodayar, Kalakad to Sengaltheri, Manimuthar and Papanasam) and these regions will form the "Manipulative or Buffer Zone", managed for research, education and training activities. Several pockets in these regions are heavily disturbed for the cultivation of teak and rubber (Manipulation — Forestry), and cultivation of Banana, Coffee, Tea, Tapioca, Cardamom, etc. (Manipulation — Agriculture). In the foothills heavy natural or human — caused alterations have taken place, especially in and around the catchment areas of the four major river valley projects namely, Papanasam hydro-electric project, Manimuthar irrigation project, Kodayar hydro-electric project and Neyyar irrigation scheme, form the "Reclamation or Restoration Zone". There are several areas of tribal settlements, namely, Inchikuzhi, Kanthaparai, Anchinazhiathodu, Kodumadi, Kilaviarumalai and Lower Kodayar which will form the "Stable Cultural Zone" of the biosphere.

VI. **Human Impact:** This proposed biosphere reserve located at the southern end of Western Ghats is well protected by natural barriers both by land and seas. The core region is remotely located and completely free from human activities. The biosphere reserve is by and large, already well protected because of the constitution of three well established sanctuaries, namely, Mundanthurai Wild Life Sanctuary, Kalakadu Sanctuary and Neyyar Wild Life Sanctuary. The area also provides examples of a number of human activities in the buffer zone, reclamation zone and cultural zone.

VII. **Tribals:** Inchikuzhi, Kanthaparai, Lower Kodayar and Anchunazhiathodu are some of the areas where there are settlements of a hill tribe known as 'Kanis'. They live partly on leaves, tubers and fruits of forest plants and by hunting wild animals. In recent years some of them are employed in hydro-electric projects, private estates and forest departments. Even now many of them live on wild plants and animals, and they offer much scope for ethnobiological studies.

VIII. **Selection criteria:**

1. *Representativeness*: Broadly, an overall representation of the biota of the Western Ghats, particularly of the southern part, is found in Agastyamalai and its environs. Out of about 5000 vascular plant species occurring in the erstwhile Madras Presidency, the proposed biosphere harbours over 2000. As the area is located at the southern end of Peninsular India, the Indian Ocean, Arabian Sea and Bay of Bengal act as barriers towards the south, against migration of plants from other countries. The natural barriers, varied altitude, habitats, climate and rainfall have

resulted in the development of a unique flora and fauna. About 150 localised endemic species of plants occur in this region.

In recent years about 25 new taxa of plants have been discovered from the area, and some of them are *Cheilanthes keralensis* Nair & Ghosh, *Euphorbia santapaui* Henry, *Homalium jainii* Henry & Swamin., *Hoya kanyakumariana* Henry & Swamin., *Indotristicha tirunelveliana* Sharma *et al.*, *Marsdenia tirunelvelica* Henry & Subr., *Memecylon subramanii* Henry, *Reidia singampattiana* Sebastine & Henry, *Rhynchosia jacobii* Chandrabose & Shetty, *Tylophora subramanii* Henry and *Zenkeria sebastinei* Henry & Chandrabose. *Janakia arayalpathra* Joseph & Chandrasekaran, a new genus and species was also discovered. The following are some of the endemic trees restricted only in the biosphere reserve and its neighbourhood: *Aglaia elaegnoidea* (Juss.) Benth. var. *bourdillonii* (Gamble) K.K.N. Nair, *Diospyros barberi* Ramas., *Elaeocarpus venustus* Bedd., *Eugenia floccosa* Bedd., *E. rottleriana* Wight & Arn., *E. singampattiana* Bedd., *Garcinia travancorica* Bedd., *Humboldtia unijuga* Bedd., *Symplocos barberi* Gamble, *S. oligandra* Bedd., *Syzygium microphyllum* (Bedd.) Gamble. Among the large number of endemic herbs, shrubs and climbers localised in this tract, a few are: *Belosynopsis kewensis* Hassk., *Crotalaria scabra* Gamble, *Desmodium dolabriforme* Benth., *Eugenia rottleriana* Wight & Arn., *Exacum travancoricum* Bedd., *Grewia pandaica* J. R. Drumm., *Hedyotis villosostipulata* (Gamble) Rolla Rao & Hemadri, *Impatiens travancorica* Bedd., *Knoxia linearis* Gamble, *Octotropis travancorica* Bedd., *Psychotria globicephala* Gamble, *Senecio calcadensis* Ramas., *Sonerila clarkei* Cogn., *Symplocos sessilis* Clarke and *Vernonia gossypina* Gamble. One striking peculiarity of this area lies in the large preponderance of several typical Sri Lanka plants.

2. *Ecosystem Diversity*: The proposed reserve displays a tremendous diversity of plant and animal life due to its geographical position, variation of altitudinal zones, rainfall, presence of large number of tributaries of the river systems, soil types etc. Almost all vegetation types known from the Western Ghats ranging from Scrub forests to Wet evergreen formations, and subtropical Montane forests interspersed with Grassy Swards occur in this region (*vide* II. Vegetation). The complexity and diversity of flora make it an ideal genepool sanctuary. Further the area harbours a number of endemic species of plants that are unique to Peninsular India.

3. *Naturalness*: The entire region around Agastyamalai peak and also large patches especially around Mahendragiri peak and Muthukuzhivayal possess natural biota. These areas represent natural forests which had developed perhaps in course of millions of years of evolution. Large populations of wild varieties of cultivated plants occur in this region. Even inspite of the various irrigation and hydro-electric projects in the close vicinity some of the areas have never been explored due to the inaccessibility of the difficult terrains in the region. The Singampatti R.F. however, has been considerably disturbed due to cultivation of tea and other plantation crops, and irrigation projects.

4. *Effectiveness as a conservation unit*: The proposed biosphere reserve still harbours natural ecosystems in an extensive contiguous area. Also it is well protected in nature by its remote location, very dense growth of vegetational cover and surrounded by large hilly tracts. Further, the already well established three sanctuaries, namely, Mundanthurai Wild Life Sanctuary, Kalakad Sanctu-

ary and Neyyar Wild Life Sanctuary, protect about 870 sq. km of forest tracts. Hence it requires minimal additional management for the conservation of the biosphere in its totality. Thus, in terms of compactness of area and lack of human pressures, the proposed biosphere reserve is likely to receive adequate protection, and undoubtedly it forms a very viable conservation unit in southern India.

5. *Knowledge of the area's history* : The Agastyamalai mountain range figures prominently in legends and Hindu Mythology. The region is known for its rare herbs, still widely used in ayurvedic medicines. The 'Pothikaimudi' or 'Agasthyarkudam', the tallest peak in the range is associated with the sage Agastya who is said to have lived here on leaves, tubers, fruits and sap of wild plants. The orthodox belief is that Agasthya Maharishi, regarded by modern scholars as the pioneer exponent of astronomy and Aryan civilization in southern India, the originator of Sidha System of medicine and father of the hill and Tamil language, still lives on the peak as a yogi in pious seclusion. It was formerly an important astronomical station where two series of observation were taken by Mr. Broun between 1853 and 1865.

6. *Completeness of flora and fauna surveys* : Though the area attracted Naturalists since the 18th century, intensive field studies were carried out during the last two decades by the Staff of Botanical Survey of India and Zoological Survey of India, and other agencies. The floristic surveys have resulted in the discovery of many new taxa and several new records for India (*vide* VIII. 1.). A consolidated account of the flora of this region is being prepared for publication.

7. *Presence of rare and endangered species*: This area has a unique flora with about 150 local endemics (*vide* VIII. 1.). About 35 rare, endangered/threatened plant species occur here. Some of them are *Hedyotis travancorica* Bedd., *H. barberi* (Gamble) Henry & Subr., *H. villosostipulata* (Gamble) Rolla Rao & Hemadri, *Knoxia linearis* Gamble, *Vernonia heynei* Bedd. ex Gamble, *Marsdenia tirunelvelica* Henry & Subr., *Paphiopedilum druryi* (Bedd.) Pfitz., *Popowia beddomeana* Hook. f. & Thoms., *Piper barberi* Gamble, *Rhynchosia jacobii* Chandrabose & Shetty and *Toxocarpus beddomei* Gamble.

It is of interest to record a good population of the endangered lion-tailed macaque (*Macaca silenus*) in this region.

8. *Potential for research and training activities* :The occurrence of a large number of wild relatives of cultivated plants such as *Elettaria cardamomum* (Roxb.) Maton, *Mangifera indica* L., *Musa superba* Roxb., *Oryza granulata* (Nees) Arn. ex Steud. and *Paphiopedilum druryi* (Bedd.) Pfitz. prove this area to be an ideal genetic reservoir of wild species. All the four contiguous zones of the proposed Biosphere (*vide* V.) have quite a potential for various research and training activities. The Core zone with its undisturbed ecosystem offers much scope for monitoring and non-manipulative research to study the processes and changes occurring without human intervention in the area. The buffer zone encircling the Core zone is potential for manipulative research activities and training in various disciplines of Forestry, Agriculture and Horticulture, and also research into the scientific basis for ecosystem conservation. It also provides natural areas for long term continuous research and monitoring. The four major river valley projects of this area offer enormous opportunity for various impact studies in environmental research, as well as restorative research designed to study ways of rehabilitating degraded ecosystem.

The Stable Cultural Zone of the biosphere is potential for preservation of traditional tribal approach to harmonious use of environment; also there is scope for intensive ethnobiological studies.

Conclusion

The establishment of the proposed biosphere reserve will serve for the protection of the non-renewable natural ecosystems which exist over millions of years. In view of the fact that both rain forests and wild populations of non-human primates are becoming increasingly rare on a world scale, it is imperative that an area of the size and importance of Agastyamalai be given the fullest study and protection. The area is also unique in having many endemic species and is a genetic reservoir of many wild relatives of cultivated plants. Hence, studies should be carried out on topographical features, water flows, geology and soils, natural and man-modified vegetation types, distribution and diversity of species, human settlements, climatology, concentration of atmosphere and water pollutions, productivity, phenology and mineral cycling. It is gratifying to note that the MAB National Committee of the Department of Environment, Govt. of India which has undertaken the task of identifying areas for designation of biosphere reserves, has already taken into consideration this potential area, and we earnestly appeal that speedy steps for collection of any additional data required for the conservation of this area in its totality be undertaken, so that it may serve as an "ecological protectorate".

References

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A PROVISIONAL LIST OF UNRECORDED SOUTH-EAST ASIAN BIRDS[1]

D. Couzens, R. J. Quinnell and J. Bass[2]

This paper is intended as a guide to potential bird sound recordists in South-East Asia, suggesting which species deserve particular attention in the search for a complete record of the bird vocalisations of the area. It has been written as a result of a suggestion put forward by T. C. White at the biennial meeting of the International Bio-Acoustics Council at Sussex, England in September 1981. The proposal was to review progress in bird sound recording throughout the world and to publish lists of unrecorded birds for various regions. A Working Group was subsequently set by IBAC and this list is the first result of their research.

The South-East Asian area used is that delineated by King, Dickinson and Woodcock (1975). In compiling the list we used a base consisting of all birds given a number in KDW, and omitted each bird whose voice we found in any one of our sources (see Appendix 1). The remainder are cited below with their numbers. Obviously our list does not represent the complete picture, and we are most keen to hear from recordists that have any of the birds in their collection.

It is most important to stress that this list is not intended to focus undue attention on the pursuit of recording 'new' birds, for most of the South-East Asian avifauna is not fully recorded. Indeed, well over half the species we omitted were very poorly represented in our main sources, the British Library of Wildlife Sounds and the Library of Natural Sounds, Cornell University (less than five recordings combined). Many of the species which had been recorded are widespread in distribution and may not actually have been taped in the region concerning us; others may have been recorded in captivity. Moreover, there is no guarantee that any recordings are of good technical quality for a given species. Probably less than fifty mainly South-East Asian birds have had good coverage of their vocabularies. Therefore, whilst it is hoped that attention will be paid to the species herein, this will not detract from the interest in taping 'common' birds.

We are greatly indebted to Ron Kettle, curator of the British Library of Wildlife Sounds, and to Dr. James Gulledge at the Cornell University Laboratory of Ornithology for access to collection lists and information on published recordings. Lt.-Col. Terry White and Ken Scriven also deserve special mention. Finally, thanks are due to the various recordists who have contributed tape copies or information to sound libraries and have, of course, recorded the birds.

The list

Quoted numbers and taxonomy follow King, Dickinson and Woodcock. The species are grouped into families, the family name being succeeded by two figures. The first refers to the number of unrecorded species, the second to the total number of species, in South-East Asia. Endemic birds are indicated by an asterisk (*), endangered birds by a/.

[1] Accepted July 1983.

[2] The British Library of Wildlife Sounds, The National Sound Archive, 29 Exhibition Road, London SW7 2AS, England.

HYDROBATIDAE (1, 2)
8 *Oceanodroma monorhis*
PELECANIDAE (1, 3)
11 *Pelecanus philippensis*
PHALACROCORACIDAE (2, 5)
16 *Phalacrocorax fuscicollis*
19 *Anhinga melanogaster*
FREGATIDAE (2, 3)
20/ *Fregata andrewsi*
22 ——— *ariel*
ARDEIDAE (8, 21)
23 *Ardea insignis*
24 ——— *sumatrana*
29 *Ardeola bacchus*
30 ——— *speciosa*
33/ *Egretta eulophotes*
38 *Gorsachius melanolophus*
40 *Ixobrychus eurhythmus*
42 *Dupetor flavicollis*
CICONIIDAE (5, 9)
44/ *Ibis cinereus*
49 *Ciconia episcopus*
50 *Xenorhynchus asiaticus*
51 *Leptoptilos dubius*
52 ——— *javanicus*
THRESKIORNITHIDAE (4, 6)
53 *Threskiornis melanocephalus*
54/ *Pseudibis davisoni*
55/* ——— *gigantea*
58 *Platalea minor*
ANATIDAE (3, 35)
79/ *Rhodonessa caryophyllacea*
83 *Aythya baeri*
93/ *Mergus squamatus*
ACCIPITRIDAE (11, 50)
96 *Aviceda jerdoni*
97 ——— *leuphotes*
106 *Icthyophaga nana*
110 *Gyps indicus*
111 *Sarcogyps calvus*
119 *Circus melanoleucos*
121 *Accipiter gularis*
122 ——— *virgatus*
125 ——— *soloensis*
127 *Butastur liventer*
145 *Spizaetus nanus*
FALCONIDAE (7, 13)
146* *Polihierax insignis*
147 *Microhierax caerulescens*
148 ——— *fringillarius*
149 ——— *melanoleucos*
152 *Falco amurensis*
155 ——— *severus*
156 ——— *jugger*
PHASIANIDAE (18, 39)
159 *Francolinus pintadeanus*
161 *Melanoperdix nigra*
166 *Arborophila rufogularis*
167 ——— *atrogularis*
169* ——— *davidi*
170* ——— *cambodiana*
172 *Galloperdix oculea*
174 *Bambusicola fytchii*
176/ *Tragopan blythii*
178/ *Lophophorus sclateri*
181/* *Lophura imperialis*
182/* ——— *edwardsi*
183 ——— *erythropthalma*
185* ——— *diardi*
188/ *Syrmaticus humiae*
189 *Chrysolophus amherstiae*
191 *Polyplectron bicalcaratum*
192* ——— *germaini*
TURNICIDAE (1, 3)
198 *Turnix tanki*
GRUIDAE (1, 4)
201/ *Grus nigricollis*
RALLIDAE (4, 16)
205 *Rallus striatus*
206 *Rallina fasciata*
212 *Porzana bicolor*
214 *Amaurornis akool*
HELIORNITHIDAE (1, 1)
220 *Heliopais personata*
OTIDIDAE (1, 2)
222 *Eupodotis bengalensis*
JACANIDAE (1, 2)
224 *Metopidius indicus*
CHARADRIIDAE (2, 14)
236 *Charadrius peronii*
240 ——— *veredus*
SCOLOPACIDAE (3, 39)
251/ *Tringa guttifer*
259 *Gallinago solitaria*
267 *Calidris tenuirostris*
GLAREOLIDAE (2, 2)
286 *Glareola maldivarum*
287 ——— *lactea*
LARIDAE (3, 28)
290.1 *Larus saundersi*

306 *Sterna acuticauda*
312/ ——— *zimmermanni*
RYNCHOPIDAE (1, 1)
316 *Rynchops albicollis*
COLUMBIDAE (14, 30)
317 *Treron apicauda*
318* ——— *seimundi*
319 ——— *sphenura*
322 ——— *pompadora*
323 ——— *fulvicollis*
325 ——— *vernans*
327 ——— *capellei*
328 ——— *phoenicoptera*
329 *Ptilinopus jambu*
331 *Ducula bicolor*
333 *Columba leuconota*
335 ——— *hodgsonii*
337 ——— *punicea*
346 *Caloenas nicobarica*
PSITTACIDAE (1, 9)
355 *Loriculus galgulus*
CUCULIDAE (3, 29)
369 *Chrysococcyx maculatus*
372 ——— *malayanus*
376 *Phoenicophaeus sumatranus*
TYTONIDAE (1, 3)
386 *Tyto capensis*
STRIGIDAE (2, 23)
398 *Ketupa flavipes*
399 ——— *ketupu*
APODIDAE (6,13)
422 *Collocalia gigas*
423 ——— *fuciphaga*
428 *Hirundapus cochinchinensis*
429 ——— *giganteus*
430 *Rhaphidura leucopygialis*
431 *Apus acuticaudus*
HEMIPROCNIDAE (1, 3)
435 *Hemiprocne coronata*
TROGONIDAE (1, 7)
444 *Harpactes wardi*
ALCEDINIDAE (3, 16)
447 *Alcedo hercules*
449 ——— *meninting*
452 *Ceyx rufidorsus*
BUCEROTIDAE (2, 13)
471 *Ptilolaemus tickelli*
473 *Aceros nipalensis*
CAPITONIDAE (1, 16)
485* *Megalaima lagrandieri*
PICIDAE (10, 42)
502 *Picumnus innominatus*
503 *Sasia ochracea*
508 *Picus xanthopygaeus*
510 ——— *rabieri*
511* ——— *erythropygius*
518 *Dinopium shorii*
521 *Gecinulus grantia*
524* *Meiglyptes jugularis*
532 *Picoides atratus*
538 *Hemicircus canente*
PITTIDAE (6, 12)
552 *Pitta soror*
553 ——— *caerulea*
557* ——— *ellioti*
558 ——— *cyanea*
560/* ———*gurneyi*
561 ——— *phayrei*
HIRUNDINIDAE (2, 11)
568/* *Pseudochelidon sirintarae*
571 *Hirundo concolor*
CAMPEPHAGIDAE (5, 20)
579 *Hemipus picatus*
585* *Coracina polioptera*
592 *Pericrocotus cinnamomeus*
593 ——— *igneus*
594 ——— *erythropygius*
CHLOROPSEIDAE (1, 8)
601 *Aegithina lafresnayei*
PYCNONOTIDAE (7, 39)
611 *Pycnonotus melanoleucos*
615 ——— *cyaniventris*
617 ——— *xanthorrhous*
626* ——— *blanfordi*
637 *Hypsipetes viridescens*
643 ——— *castanotus*
645* ——— *thompsoni*
ORIOLIDAE (2, 8)
655 *Oriolus tenuirostris*
659 ——— *mellianus*
CORVIDAE (6, 22)
665 *Urocissa whiteheadi*
671 *Dendrocitta frontalis*
672 *Crypsirina temia*
673* ——— *cucullata*
674 *Temnurus temnurus*
682 *Corvus torquatus*
AEGITHALIDAE (1, 2)
683 *Aegithalos iouschistos*

PARIDAE (1, 10)
688.1 *Parus venustulus*
SITTIDAE (5, 9)
695 *Sitta nagaensis*
698* —— *victoriae*
700* —— *solangiae*
702 —— *magna*
703 —— *formosa*
TIMALIIDAE (45, 139)
713 *Pellorneum albiventre*
726.1 *Pomatorhinus erythrocnemis*
730 ———— *ochraceiceps*
733* *Jabouilleia danjoui*
734 *Rimator malacoptilus*
737 *Napothera marmorata*
743 *Spelaeornis troglodytoides*
744 ———— *formosus*
745 ———— *chocolatinus*
746 *Sphenocichla humei*
747* *Stachyris rodolphei*
752* ———— *herberti*
761* *Macronous kelleyi*
767* *Turdoides gularis*
768 ———— *longirostris*
769 *Babax lanceolatus*
778* *Garrulax milleti*
779 ———— *maesi*
781 ———— *nuchalis*
782* ———— *vassali*
783 ———— *galbanus*
784 ———— *delesserti*
785 ———— *cineraceus*
791 ———— *merulinus*
793 ———— *sannio*
794 ———— *virgatus*
795 ———— *austeni*
800* ———— *yersini*
801 ———— *formosus*
802 ————*milnei*
803 *Liocichla phoenicea*
809 *Pteruthius xanthochlorus*
815 *Actinodura waldeni*
816 ———— *souliei*
817 *Minla cyanouroptera*
821 *Alcippe cinerea*
824 ——— *ruficapilla*
826 ——— *rufogularis*
833* *Crocias langbianis*
834 *Heterophasia annectens*
835 ———— *gracilis*
837 ———— *pulchella*
842* *Yuhina humilis*
844 ——— *diademata*
846 ——— *nigrimenta*
PANURIDAE (8, 12)
851 *Paradoxornis unicolor*
852 ———— *flavirostris*
853 ———— *guttaticollis*
855 ———— *alphonsianus*
858 ———— *davidianus*
859 ———— *atrosuperciliaris*
860 ———— *ruficeps*
861 ———— *gularis*
TURDIDAE (23, 71)
866 *Erithacus sibilans*
870 ———— *ruficeps*
871 ———— *obscurus*
872 ———— *pectardens*
878 *Tarsiger hyperythrus*
883 *Phoenicurus hodgsoni*
885 ———— *schisticeps*
891 *Grandala coelicolor*
892 *Enicurus scouleri*
894 ———— *immaculatus*
898 *Cochoa purpurea*
899 ——— *viridis*
901 *Saxicola leucura*
903 ———— *jerdoni*
905 *Thamnolaea leucocephala*
907 *Monticola gularis*
910* *Myophonus robinsoni*
912 *Zoothera interpres*
916 ———— *dixoni*
919 ———— *marginata*
920 *Turdus dissimilis*
921 ——— *hortulorum*
928 ——— *feae*
SYLVIIDAE (13, 71)
937 *Seicercus poliogenys*
938 ———— *castaniceps*
939 ———— *montis*
941 *Abroscopus schisticeps*
945 *Phylloscopus subaffinis*
947 ———— *armandii*
960 ———— *cantator*
961 ———— *ricketti*
969 *Acrocephalus concinens*
974 *Graminicola bengalensis*
996 *Cettia major*
1002 *Bradypterus luteoventris*
1003 ———— *seebohmi*

MUSCICAPIDAE (16, 53)
1005 *Rhinomyias brunneata*
1008 *Muscicapa griseisticta*
1010 ———— *williamsoni*
1011 ———— *muttui*
1014 *Ficedula zanthopygia*
1019 ———— *monileger*
1022 ———— *dumetoria*
1023 ———— *hodgsonii*
1027 ———— *sapphira*
1031 *Niltava davidi*
1033 ——— *sumatrana*
1034 ——— *vivida*
1035 *Cyornis concreta*
1036 ———— *ruecki*
1037 ———— *hainana*
1042 ———— *turcosa*
MOTACILLIDAE (1, 14)
1065 *Dendronanthus indicus*
LANIIDAE (3, 7)
1077 *Lanius tigrinus*
1078 ——— *collurioides*
1081 ——— *sphenocercus*
STURNIDAE (8, 18)
1083 *Saroglossa spiloptera*
1085 *Sturnus sericeus*
1086 ———— *sinensis*
1087 ———— *sturninus*
1090 ———— *contra*
1091 ———— *nigricollis*
1095 *Acridotheres javanicus*
1098 *Ampeliceps coronatus*
NECTARINIIDAE (7, 24)
1100 *Anthreptes simplex*
1102 ———— *rhodolaema*
1107 *Nectarinia calcostetha*
1110 *Aethopyga gouldiae*
1112 ———— *christinae*
1118 *Arachnothera crassirostris*
1121 ———— *chrysogenys*
DICAEIDAE (6, 12)
1124 *Prionochilus thoracicus*
1125 ———— *maculatus*
1126 ———— *percussus*
1128 *Dicaeum everetti*
1130 ———— *melanoxanthum*
1132 ———— *erythrorhynchos*
ZOSTEROPIDAE (1, 4)
1136 *Zosterops erythropleura*
PLOCEIDAE (6, 17)
1146 *Ploceus hypoxanthus*
1148 *Erythrura prasina*
1149 ———— *hyperythra*
1152 *Lonchura leucogastra*
1153 ———— *leucogastroides*
1156 ———— *maja*
FRINGILLIDAE (9, 34)
1157 *Serinus thibetanus*
1159 *Carduelis spinoides*
1160 ———— *ambigua*
1165 *Carpodacus eos*
1166 ———— *vinaceus*
1168 ———— *rhodopeplus*
1169 *Pinicola subhimachala*
1174 *Coccothraustes migratorius*
1178 *Pyrrhoplectes epauletta*

ANALYSIS

309 species of the birds of South-East Asia have yet to have their voices recorded. This is some 26% of the avifauna. If South-East Asia is taken to be representative of the world as a whole, then about 2300 of the world's 9000 bird species are as yet unrecorded.

32 of the 309 are endemic (they only occur in South-East Asia), and must obviously be sought in the area concerning us. Many of the birds are rare, especially the 17 that are considered threatened (see King 1981). At least one of these is generally supposed to be extinct already, the Pink-headed Duck (*Rhodonessa caryophyllacea,* no. 79). Others are extremely local : both *Garrulax yersini* (800) and *Crocias langbianis* (833), for example, are only found on the Langbian Plateau, South Annam. It is important that, where possible, these birds should be recorded before they become too rare to find or are even lost to extinction.

Taking the 23 areas of South-East Asia set out by KDW, about six of them, on average, make up the breeding range of each bird. To

give an indication of which areas are most in need of recording work, the table below shows the number of unrecorded species that occur or have occurred in each area. The number of those which breed is given in brackets :

West Burma	134	(114)
Northeast Burma	132	(109)
Northwest Thailand	128	(90)
North Laos	122	(97)
East Burma	119	(98)
Tenasserim	115	(93)
Tonkin	115	(90)
Malaya	104	(71)
South Burma	104	(77)
Peninsular Thailand	90	(70)
South Annam	89	(79)
Central Burma	85	(69)
South Laos	83	(70)
Cochinchina	83	(69)
Cambodia	79	(62)
Central Laos	78	(65)
Central Annam	70	(56)
Southeast Thailand	67	(49)
North Annam	64	(50)
Central Thailand	60	(43)
Southwest Thailand	58	(44)
Northeast Thailand	57	(42)
Hong Kong	42	(10)

A similar analysis of the habitats of the birds reveals that about 60% of them breed in forests of various kinds. This confirms the view expressed by T.C. White and others that it is in forests that the greatest effort and ingenuity needs to be called upon by future recordists.

Finally, it is apparent that some families of birds pose more problems to recordists than others, for various reasons. Among the most under-recorded families are Panuridae, Sittidae, Falconidae, Dicaeidae, Pittidae and Muscicapidae and there are also under-recorded genera such as *Garrulax* and *Treron.* Perhaps it would be of particular interest to search for these.

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APPENDIX I: SOURCES

Libraries

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The Library of Natural Sounds, Cornell University Laboratory of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850, USA. (Up to September 1981).

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Private Collections

We have used lists of species recorded by :

H. BARTELS and H. GROENEVELD
B. and L. COFFEY
M. COMAR
F. M. GAUNTLETT
D. A. HOLMES
R. KENNEDY
B. F. KING
G. MADGE
J. T. MARSHALL
H. E. MCCLURE
T. ROBERTS
J. ROCHE
L. SHORT
R. K. TEMPLETON
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REPRODUCTIVE BIOLOGY OF THE MUGGER (CROCODYLUS PALUSTRIS)[1]

Romulus Whitaker[2] and Zahida Whitaker[3]

(*With two plates & five text-figures*)

Mugger *(Crocodylus palustris)* were studied in the wild at locations in India and Sri Lanka and in captivity in Madras. Mugger range from Iran east to Assam in India and south to Sri Lanka; they have been exterminated throughout most of their range.

Mugger are adaptable and occupy a wide range of habitats, including streams, rivers, lakes and saline lagoons. Basking is an important daily activity and was noted to decrease in the hot season or when a strong breeze was blowing. Mugger have developed two main strategies to survive their highly seasonal environments : tunnelling and overland travel. They are strong swimmers and use the high walk and belly run for terrestrial locomotion.

Mugger can be fast when catching prey; hatchlings were observed jumping to catch flying insects and captive adults caught wild monkeys, crows and kites. In some localities they are mainly fish eaters. Other prey items include beetles, rats, snakes and frogs. Man eating is rare, the Sri Lanka race receiving most credit for this habit. Gastroliths were often found in mugger stomachs through their function, if any, remains unknown. Mugger have acute senses of sight, hearing and smell.

Hatchling mugger averaged 27 cms in total length; the maximum recorded length for the species was 5.63 m. A captive-reared female of 2.20 m bred at 6 years 8 months.

November to June is the breeding season in South India and a month later in the north. Mugger are fairly tolerant of conspecifics. Prominent social signals by the male included head slapping, chasing, tail up swimming, geysering and bellowing. Females defended nest sites by tail thrashing and chasing. Submission was signalled by raising the head.

During courtship circling, bubbling and jaw touching preceded copulation. Females lay an average of 25-30 eggs in holes within 10 metres of the water incubation averages 66 days. Double clutching was observed for 5 years in captive mugger in Madras. Nest defence, hatching, release and transport of young was observed in captivity. Defence of hatchlings was observed in both sexes. Conservation included egg collection, rearing and release.

[1] Accepted March 1983.

[2] Madras Snake Park Trust, Guindy Deer Park, Madras 600 022, South India.

[3] Madras Crocodile Bank Trust, Vadanemmeli Village, Perur Post, Mahabalipuram Road, Chingleput Dist., Tamil Nadu.

Introduction

By the time formal studies were started on this crocodile the mugger (*Crocodylus palustris*) had been exterminated throughout most of its range (Whitaker and Daniel 1978).

Only small, remnant populations remain. In parts of Sri Lanka however the mugger can still be found in concentrations of 100 or more in a single tank (man made lake) (Whitaker and Whitaker 1979).

Till the 1970's the only scientific reports on the species were miscellaneous notes mainly in the Journal of the Bombay Natural History Society. McCann (1940) and D'Abreu (1915) made some of the first observations on breeding and feeding habits of mugger, and M. A. Smith (1927, 1935) did the first major work on its systematics and distribution. P. E. P. Deraniyagala made the first systematic effort to formally record data on the mugger's taxonomy and embryology (1936, 1939).

Yadav (1969) and David (1970) reported on captive breeding of the mugger. In the early 1970's mugger were housed at the Madras Snake Park (MSP) and later (1974) as a breeding group of the then established Madras Crocodile Bank (MCB). What little we know of the behaviour of the mugger is based mainly on observations of captive animals. Parker (1880) and Dharmakumarsinhji (1947) published the first notes on wild mugger breeding behaviour. An account of captive breeding behaviour was made by Whitaker and Whitaker (1977 a, b).

Other literature on the mugger includes references on where and how to shoot them (for example Shortt 1921) and status survey reports for N. E. India (Biswas 1970), South India, Gujarat (Whitaker 1974, 1977) and Sri Lanka (Whitaker and Whitaker 1979). The Govt. of India/UNDP/FAO crocodilian rehabilitation programme is undertaking several studies of the mugger, publications on which are anticipated.

This treatment of mugger biology outlines current knowledge of their distribution, status, habits and conservation and concentrates on reporting results of our studies on the breeding biology of the species.

Materials and Methods

Studies on wild crocodiles

We have been involved in the survey, study and captive breeding of mugger in India since 1970. Day and night census was carried out in Tamil Nadu, Karnataka, Gujarat States, Sri Lanka and western Nepal. Prolonged observations were made in Corbett National Park, Uttar Pradesh, North India. Wild egg collection was undertaken in Tamil Nadu and Gujarat.

Captive facility

Captive mugger have bred for seven years in Madras, South India. At MSP, a breeding pair resides in a 310 m^2 walled enclosure. The 18 m^2 concrete pond is surrounded by natural scrub. The soil is laterite, hard and pebbly. The present breeding group of 12 adults (4 males, 8 females) at MCB is housed in a large (1780 m^2) walled and naturally landscaped enclosure which is planted with common coastal vegetation (*Casuarina, Pandanus*, grasses). The pond is an excavation filled by the natural acquifer, varying in area from 600 to 1200 m^2 and 1-2.5 m in depth in the dry and wet seasons. The substrate is sea sand and temperatures, rainfall and feed the same as at MSP. 900 juveniles and subadults are also being reared at MCB. Data from these animals has provided much of the information reported herein. Mugger at both facilities are fed rats, frogs, fish and beef. In Madras, rain is confined mainly to the northeast monsoon (October-December) with an annual average of 1200 mm. Shade temperatures throughout the year range from 20° to 45° C.

Results and Discussion

Distribution

Mugger are found from the Sarbaz River in southeastern Iran east to Assam and south to Sri Lanka (Honegger 1971). The validity of a single record of a mugger in Thayetmyo, Burma (Annandale 1921) is doubted by M. A. Smith (1927). The species occupies a variety of habitats and was apparently once very common in many parts of its range (Shortt 1921, Deraniyagala 1939). In Sri Lanka, a single specimen was reported at Kandy, 450 m. above sea level (Whitaker and Whitaker 1979) and in India the highest confirmed record is at Corbett Park, 420 m. above sea level.

Status

The species is regarded as endangered; exterminated in most of its range, rare in Iran, and near extinction in Pakistan (Webb 1978). It is listed in the IUCN Red Data Book and is on Appendix I of the Convention on International Trade in Endangered Species. Mugger are protected by law in all the countries of their occurrence.

The once large population of captive mugger at Mugger Pir in Pakistan has dwindled to three adults (H. W. Campbell, pers. comm.). The two largest known concentrations of the species on the Indian subcontinent are at Amaravathi Reservoir, Tamil Nadu State with about 14 adults and Hiran Lake, Gujarat State, with about 50 adults.

Habitat

Though named *palustris* (swamp dwelling), mugger are mainly river and lake dwellers, adjusting to a wide range of habitats. We have encountered mugger in diverse habitats including hill streams, large man-made reservoirs, annual tanks, large rivers, small jungle pools, irrigation channels and saltwater lagoons. Habitat preference may be limited by their hole nesting habits. Carr (1963) proposed that mound nesting would appear an adaptation to swampland by truly palustrine species such as *Crocodylus novaeguineae* and *Alligator mississippiensis.* In fact the Indian mainland has relatively little freshwater swamp habitat. The present day largest populations of mugger are found in the annual tanks of the 'dry zones' of Sri Lanka; only here do they approach what might be called original concentrations. Deraniyagala (1936, 1939) notes that mugger in Sri Lanka are found mainly in lowland rivers, lakes, forest pools and, remarkably, in the salt pans and associated lagoons.

On the Indian sub-continent mugger have been recorded in the salt lakes near Thatta in the Sind (McCann 1940). Bustard (1974) notes their "adaptability to village and irrigation tanks in addition to rivers, swamps and lakes." He also writes that much of their habitat has been "affected by dam construction" as in Sri Lanka where natural habitat has been altered by thousands of miles of canals and channels. Sometimes however these modifications are beneficial to crocodiles, offering alternate habitat, hunting grounds and access to other tanks (Whitaker and Whitaker 1979).

Daily Activity

Amphibious behaviour

During the 1977/78 breeding season (December-January) ZW made 55 hours of behavioural observations on the mugger breeding group at MCB. Observations were made from a hide in the enclosure, generally during the most active period, i.e. early

morning and late evening. Activities of seven mugger were recorded during a week in mid-January. Table 1 shows the percentage of time spent at each activity. Most crocodiles spent over half their time stationary in the water though the dominant female (Nova) spent more time on the bank. The dominant male (Perayur) spent more time swimming than the others. The 4 sub-dominant females were the least active of all. During the hot season (April-July) the MCB mugger spend most of the day under water and only emerged onto the bank during the night.

April, mugger typically moved onto land from 7 a.m. (air temperature 18-21° C) till noon (35-39° C). No further emergence occurred till well after sunset when the largest mugger (over 3 m.) would emerge on to the rocks (Whitaker 1979 b).

Burrowing, aestivation and *seasonal movement*

Writing of mugger in the northern peninsula of Sri Lanka Baldeus (1671) related, "In Jafnapatnam there are many crocodiles in the fens, ponds, and lakes, which if they happen to dry up in the summer, they dig holes to live in . . . ." Later Deraniyagala (1936) writes that the mugger "often excavates burrows in the bank." In the salt lakes near Thatta in the Sind (Pakistan), mugger were observed occupying burrows on the hills bordering the lake. The holes were about 60 cm in diameter and 2.5 to 4.5 m. deep, ending in a chamber wide enough for the crocodile to turn around in (McCann 1940).

In South India two burrows of about 0.75 m diameter and 2.5 m. deep were seen at Kilikudi, Tamil Nadu and described "perhaps as a hot season refuge" (Whitaker 1974).

TABLE 1

DAILY ACTIVITY OF CAPTIVE MUGGER IN SOUTH INDIA (MCB) DURING A WEEK (MID-JANUARY) IN THE BREEDING PERIOD (% OF TIME SPENT)

Crocodile age (years) / length (cms)	Partly or fully on bank	Stationary in water	Swimming	Courtship	Other social interaction	Underwater
Perayur (Beta) male/19(282)	28.2	57.7	7.0	1.4	—	5.6
Nova (Alpha) female/17 (200)	52.1	41.1	2.7	1.4	—	2.7
Metty female/7 (270)	35.3	61.8	2.9	—	—	—
4 females 6-9/(152-188)	19.7	78.8	1.5	0.08	—	—
Average	33.8	59.8	3.5	0.96	—	4.1

At Vakkaramari Waterworks in mid-May, adult mugger took an average of two hours (0600-0800) to gradually reach shore before emerging onto land. Then, they spent an average of 3½ to 4 hours on shore. Afternoon emergence was rare, probably because of a daily brisk northwest breeze (Whitaker 1974). At MCB a similar schedule has been observed; diurnal basking is significantly less in the hot season, when the crocodiles spend most of the day submerged. At Corbett National Park in

In Kedarhalla stream, burrows up to 6 m. deep under the supportive root systems of trees (e.g. *Eugenia jambolana*) on the banks are the only refuges for the mugger there during the prolonged dry season (Whitaker and Whitaker 1976). One was horse-shoe shaped with two openings. We saw similar burrows in stream banks on the Menik Ganga river near Kataragama in Sri Lanka and in the Gir Forest, Gujarat. At Hiran Lake in the Gir National Park, 16 burrows, all with flattened openings, averaging 80 cms in width, 4-5 m. deep and almost every one containing a mugger were observed on a steep embankment. Some of the holes were at water level, and some 3 m. up the bank (Whitaker 1977). In southern Sri Lanka a mugger resided in a burrow dug in the sand bank of a saltwater lagoon (Whitaker and Whitaker 1979). After several abortive attempts, a 3 m. male mugger at MCB excavated a burrow under the overhanging roots of several *Casuarina* trees in the mugger breeding pen.

Burrowing has been observed in yearling, subadult and adult mugger at MCB. Burrowing seems to be a survival tactic in mugger to withstand the drought conditions which are a standard feature of the dry season in many parts of the range. However in some situations mugger although they frequent the water, appear to reside permanently in burrows, emerging to bask by day and hunt at night.

An adult MCB female mugger 'Metty' was observed several times while burrowing. Inserting her head under the tree roots she would dig with front feet and propel the sand back with the hind feet, dispersing sand with swimming movements of the tail. The dominant female in the pen would often use the tunnel (which was located close to her nest site) with no apparent objection on the part of the Metty. In the wild in India only one mugger was observed per tunnel although at the Menik Ganga study site, it was thought that many of the mugger observed at night resided in the 3 tunnels located (Whitaker and Whitaker 1979). It seems likely that mugger will group together in a single tunnel as observed in the Nile crocodile (Guggisberg 1972).

Overland travel by mugger is well documented. In India they travel overland at night to the nearest tank when the water dries in summer (Ahmed 1945). In Sri Lanka, trans-tank migration is a yearly phenomenon during the dry season (Whitaker and Whitaker 1979). In the Barda Hills, Gujarat, at least 50 crocodiles were reported to have left a reservoir as the dry season progressed. The trail of one subadult was followed for about $2\frac{1}{2}$ kms through steep, hot scrub jungle. The animal was found under a sheltering overhanging rock 6 kms from the next tank (Whitaker 1977). This is not a random movement.

Overland travel is a likely mode of colonization particularly by subadult and juvenile mugger. Evidence of single crocodiles present in small hill streams above waterfalls at Kedarhalla and Amaravathi in Tamil Nadu demonstrates the tenacity of the species in seeking new habitat.

Locomotion

Like other crocodilians mugger use the powerful, laterally flattened tail to swim, using the webbed hind feet to stabilize when still, change direction and aid the 'reverse dive', a typical mode of submerging. Mugger often walk lightly on the bottom of a pond or river, using the same 'belly walk' as on land. Where there is a lot of marsh gas it

is easy to see the bubble trail of a bottom walking mugger.

Mugger have not been observed galloping, though the other modes of locomotion on land, the high walk and belly run recorded for the Nile crocodile (Cott 1961 a, b) are the same. Though not classed as a regular mode of locomotion, climbing has been observed in mugger of up to 2.8 m. In captivity adult mugger climbed over vertical chain link mesh fencing 1.75 m. high and small juveniles climbed up 80 cm rough cement walls at the corners. In the wild this ability based on limb and claw strength, is used by mugger in travelling steep terrain and climbing up to burrows many metres above drought water levels.

Feeding

Mugger are heavy set animals and appear sluggish, but are actually alert and capable of fast reaction and considerable speed in defence or when hunting. Hatchlings have been observed jumping to successfully snap at winged termites and moths attracted to a light over their pond.

Mugger are curious animals and will briefly investigate any movement in or near their habitat. If interested, mugger will submerge and reappear near the potential prey. Prey is caught with a sudden forward lunge or sideways snap. Captive adults at MSP and MCB have captured monkeys, crows and kites which entered the breeding enclosures.

Small prey is killed by a quick, crushing bite. Larger prey is shaken, drowned and/or dismembered as a limb (or head) is grabbed and twisted several times while the mugger rolls in the water using tail leverage.

In some localities mugger appear to be mainly fish eaters, particularly where intense dry seasons create high concentrations of fish. Spittel (1924) writing about Sri Lanka, stated that "salt concentration causes a massive fish kill and crocodiles, birds and other scavengers feast."

The annual drying of most streams and tanks is characteristic of the geographical dry zones in the mugger's range. Large mugger establish themselves in the last remaining water, the essential focal point for a vast range of dependent animal life, and could probably survive the rest of the year on the dry month or two of super-abundance of prey.

Crocodiles were observed 'herding' fish to shore in the daytime at Hiran Lake, Gujarat and at night at Amaravathi Reservoir, catching them as they leapt in an attempt to escape from the shallows back to deep water. At MCB an adult female of 2.00 m. length was observed to purposefully herd fish after a 60 day fast during brooding. She gradually shifted her body perpendicular to the west finger of the breeding pond and slowly moved sideways, gradually reducing the enclosed end of the finger. Several bites in quick succession enabled her to catch a number of *Tilapia mossambica*. This behaviour has been observed in the wild in Nile crocodiles (Graham and Beard 1973) and the saltwater crocodile (*Crocodylus porosus*) (Whitaker, pers. obs.).

On two occasions at MSP a young adult male (2 m.) mugger was observed catching a live rat snake (*Ptyas mucosus*). Rather than killing the snake immediately at it would other prey, the crocodile shook it hard and dropped it and then repeated the process 3-4 times until the snake was motionless. The overall impression was that the mugger was hesitant with the snake.

Mugger being reared at the Gharial Rehabilitation Center in Orissa were fed pigeons which were stalked and adroitly caught (Singh 1979). In a river in Pakistan a mugger was

observed catching an otter. A captive specimen at Mugger Pir near Karachi was seen to catch a peacock (Smoothbore 1877). Besides actively hunting, mugger apparently also forage for such sedentary food items as snails and bivalves (D'Abreu 1915; Whitaker, pers. obs.) and will locate and eat carrion (Champion 1934).

Stomach contents and feces examination

A 1.35 m. mugger taken from a forest pond contained 32 water beetles (*Cybister* sp.), 15 water bugs (*Belostoma* sp.) and 4 snail opercula (*Ampullaria* sp.); the stomach of a 3.24 m specimen contained 1 Indian bullfrog (*Rana tigrina*) (D'Abreu 1915). A specimen from Powai Lake, near Bombay contained 60 water beetles, 2 fish (*Chela* sp.) and an eel (McCann 1935). Brander (1927) lists animal remains which he found in mugger shot by him: men, leopards, wild dogs, hyaenas, spotted deer, sambar, nilgai, four horned antelope, barking deer, monkeys, domestic dogs, goats, calves, pigs, ducks, storks and other birds.

Fish scales, egret feathers and watersnake (*Xenochrophis piscator*) scales were found in a sample of feces at Hiran Lake, Gujarat State (Whitaker 1977). Sixty fecal pellets representing about 30 defecations were collected and examined at Vakkaramari, Tamil Nadu State. The results indicate selective hunting for rats during the dry season (May), when rats live near water.

Prey remains	% occurrence
Fish scales	10%
Rat hair (*Bandicota bengalensis*)	100%
Gerbil hair (*Tatera indica*)	20%
Snakes scales (*Xenochrophis piscator* and *Amphiesma stolata*)	10%
Bird feathers	10%
(Whitaker 1974).	

In Sri Lanka, a random sample of mugger feces contained remains of fish, birds, wild pig (*Sus scrofa*) and Russell's viper (*Vipera russelli*).

Man-eating

It is likely that many of the reports of man-eating in mugger confuse mugger with salt-water crocodiles. It is also probable that attacks on humans are often cases of mistaken identity. Occasional attacks seem to have occurred and feeding on corpses was probably a commonplace event. Shortt (1921) describes the discovery of an entire corpse in a mugger. Often, when firewood for cremation is hard to come by, whole corpses are thrown into the river. It is likely that this is the source of ornaments found in mugger stomachs reported among others by Pitman (1913) and Battye (1944). In the present day it is common to see floating corpses on major north Indian rivers such as the Jumna and Ganga but it is now the dog packs that fatten on them, in the absence of mugger.

Deraniyagala (1936) unequivocably states that mugger in Sri Lanka will take humans as prey and in fact uses this habit as one of the criteria for calling it a sub-species separate from the Indian mugger. In 1977 a young village farmer who survived a mugger attack at a small stream in south-eastern Sri Lanka was interviewed by us. The crocodile was observed to be a 2 m. adult and this appeared to be a typical case of mis-predation (Whitaker and Whitaker 1979).

Gastroliths

While some authors suggest that the phenomenon of stone ingestion in crocodilians is an aid to digestion, Cott (1961, a, b) presents a case for the theory that gastroliths perform a hydrostatic function as ballast (a native be-

lief), the stones averaging 1% of the adult Nile crocodile's total weight. McCann (1940) suggests that the size of the stones is related to the size of the animal. A 3.42 m. mugger contained about 1 kg. of stones of assorted sizes (Simcox 1905). D'Abreu (1915) reports a 1.35 m. mugger having 16 small stomach stones and a 3.24 m. mugger with 6 large stones and 12 smaller ones. A 2.75 m. mugger found dead in Corbett National Park contained a few small pebbles and gravel in its stomach (Whitaker and Ross, unpubl.). A 3.12 m. mugger shot at Jasdan, Gujarat contained an unusually large gastrolith weighing 2.5 kgs (Dharmakumarsinhji 1952). A 3.27 m. mugger killed at the Krishnarajasagar Dam in Karnataka, South India contained 12 stomach stones of roughly 12.5 mm/diameter (Krishnamurthy 1951). Peaker (1969) observed a captive American alligator deliberately pick up and swallow pebbles of 1.5 cm diameter and describes the habit as "reminiscent of the situation in granivorous birds."

Senses

McCann (1940) notes that mugger have acute senses of sight, hearing and smell. This is supported by observations by us on captive and wild mugger. They were observed catching, moving and flying prey with great precision, demonstrating visual acuity. Wild mugger at most localities were extremely difficult to approach closer than several hundred metres; ears and eyes presumably being the important detecting devices. Mugger were observed searching for and locating prey objects on land and under water by 'feeling' with their jaws. A blind gharial (*Gavialis gangeticus*) was observed catching fish and locating dead fish, obviously by feel (Singh, pers. comm.). These observations lend support to Bellairs' (1969) suggestion that the tactile organs in the scales of the jaws may be specialized for detecting disturbance under water created by fish.

Table 2

Growth rate of 12 MSP hatchling mugger

Age	Average total length (cms)	Length gain (cms)	Average weight (gms)	Weight gain (gms)
1 month	32.1	—	48.5	—
9 months	57.2	25.1	650.8	602.3

Table 3

Growth rate of 50 MCB hatchling mugger

Age	Average total length (cms)	Length gain (cms)
Hatching	28 (26-31)	—
12 months	82 (57-104)	54
24 monhs	130 (90-170)	48

(Whitaker and Whitaker 1977 b).

Table 4

Differential growth rates in mugger

Origin	N	Months	Growth rate (cms per month)
Ahmedabad Zoo, Gujarat	6	84	1.6
Kilikudi, Tamil Nadu	4	72	7.2
MCB (captive bred)	21	48	2.3
Kedarhalla, Tamil Nadu	7	60	2.5
Hogenakal, Tamil Nadu	13	60	2.7

Size, growth rate

Mugger are 25-30.5 cm (average 27 cm) in total length when they hatch. Table 2 demonstrates an average monthly length increase of 2.8 cm and an

average monthly weight increment of 66.9 gm in 12 hatchlings for 9 months. Table 3 demonstrates increases in length of 4.25 cm per month in over 50 hatchlings for 24 months. Six hatchlings from wild collected eggs averaged 75 gms in weight at one month post hatchling and 32 months later averaged 10 kg, an increase of 310 gm per month (Whitaker 1974).

D'Abreu (1935) records a captive mugger growing from 27.5 cm to 210 cm in 19 years. An escaped mugger grew from 170 cm to 220 cm during 40 months in the wild, the only existing growth rate of a wild mugger (Acharjyo and Mohapatra 1977).

The maximum reliably recorded total length for the mugger is 5.63 m for 2 specimens killed at Kantalai Reservoir in Sri Lanka (Deraniyagala 1939). In recent years the average adult male size is 3 to 3.5 m and female 2 to 2.5 m.

Table 4 shows that mugger hatchlings of wild collected eggs and captive bred stock from different localities grew at different rates, indicating population differences in growth rates. Variable growth rates of different populations have also been reported by Bustard (in litt.).

Sexual maturity

A captive reared, 11 year old 180 cm long female mugger bred at MSP. A captive reared 220 cm female at MCB bred at 6 years 8 months and a male mugger at MSP bred when 8-10 years old and 250 cm in length (Whitaker 1979 a). McCann (1940) examined the gonads of a 180 cm female mugger which had bred that season.

Social behaviour and reproductive biology

Timing of breeding season

The breeding season of *Crocodylus palustris* (in this paper the period between and including courtship, mating, nesting and the hatch-

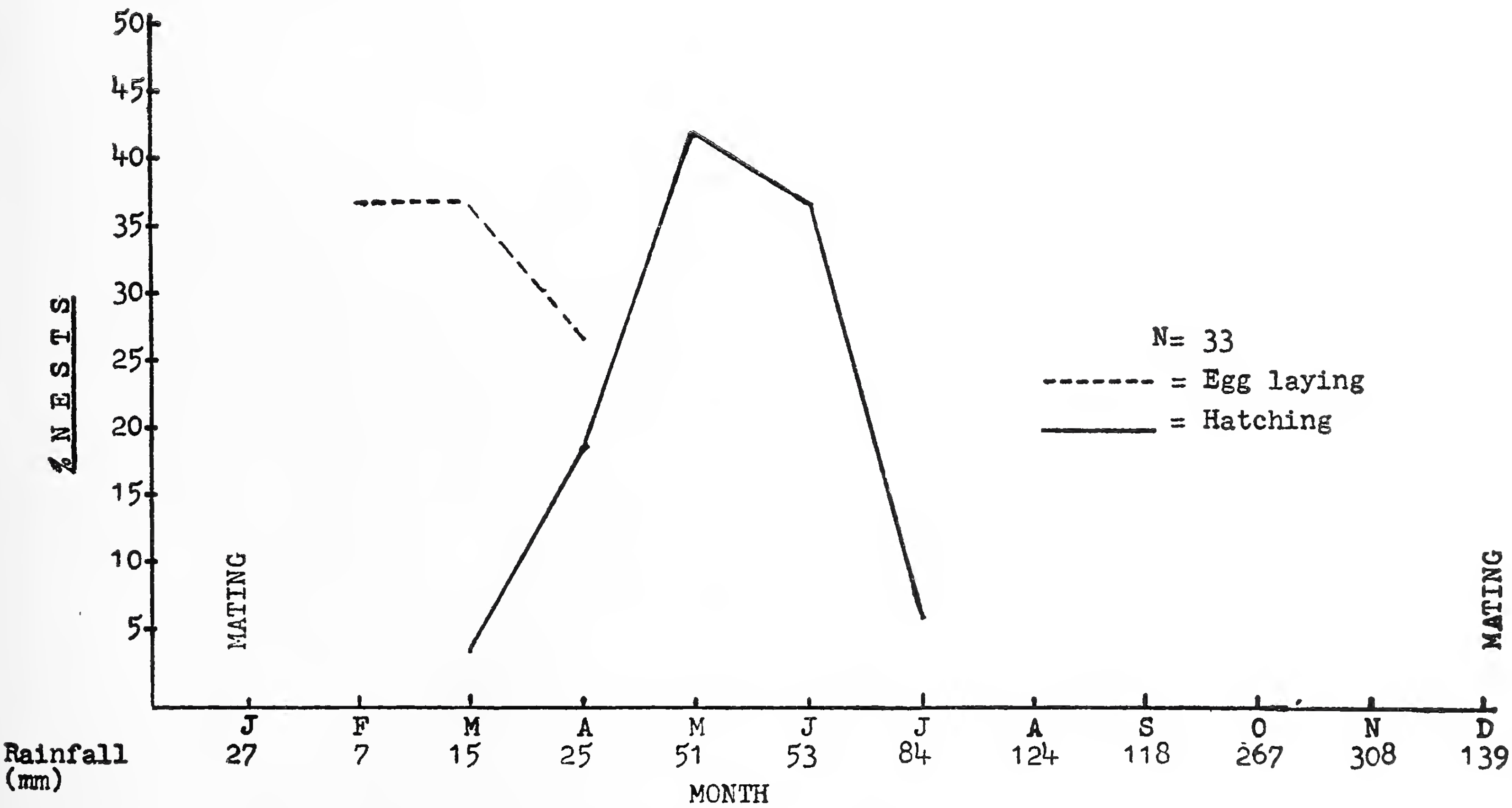


Fig. 1. Seasonability of mugger reproduction at Madras Crocodile Bank, South India.

ing of young) extends from November to June in South India. Courtship and mating coincide with the north-east monsoon, nesting with the beginning of the dry season, hatching with the height of the dry season and the beginning of the south-west monsoon. Courtship and mating commence in late-November-early December, nesting in February-April, hatching in April-June (Whitaker and Whitaker 1974, 1977 b) (see Figure 1). In northern India it tends to be one month later. In Jaipur, Rajasthan nesting is recorded for 9 May (Yadav 1969). At Jaipur Zoo from 1967-71, a female *C. palustris* nested between 25 April and 22 May, and hatching occurred between 26 June and 6 July (Prakash 1971). In Sri Lanka, June-July are reported as the laying months (Parker 1880) and August is given as a hatching date for mugger (Deraniyagala 1936) and later confirmed by Whitaker and Whitaker (1979).

Territoriality

Although fighting sometimes occurs on the introduction of a new individual in an established captive group, mugger are fairly tolerant of conspecifics, particularly during the seasonal concentrations which occur in the dry season. During the breeding (wet) season both sexes become increasingly territorial. At MCB, the largest male 'Beta' asserts his dominance by swimming displays in the 'tail up' position, head-slapping and chasing and biting subordinate males, sometimes on the shore. This behaviour has been recorded for males of other species as well, such as *C. novaeguineae* (Lang, in press) and *C. niloticus* (Modha 1967; Pooley 1976). D'Abreu (1915) notes that large wild mugger "usually" have shortened tails, some missing the terminal 9-10 segments. This is not the case with most wild mugger observed today and could be an indication of much more frequent interaction among the adults of once large and concentrated populations.

Roaring or bellowing was rarely heard in mugger but it is reported in the literature; this vocalization could be a territorial signal. McCann (1940) reports that a 3 m. mugger shot in a hole roared like "the roll of a big drum". A 3.75 m. mugger on the Indravati River, Madhya Pradesh, bellowed 2 or 3 times in quick succession and is described as sounding like a cow bellowing (Battye 1944). In Sri Lanka a mugger bellowed in response to a rifle shot (Rossel 1944).

A raised, threatening posture, called 'slimming' by Garrick *et al.* (1978) was frequently observed in captive juveniles and subadult males. The animal raises its body by fully extending its legs, sometimes slightly compressing its body laterally and breathing deeply. This is occasionally initiated by the approach of another mugger to a favoured basking spot but also by apparent individual rivalry, perhaps an early mechanism of the establishment of social hierarchy. This posture is rarely used when confronted by an animal (or human), the most common threat used being a raised forebody with open mouth, hissing and leaping forward if cornered or further threatened. A challenged subdominant mugger of either sex may run or raise the head in submission, often accompanying the signal with a low, open-mouthed gurgling sound. Other behaviours observed in mugger which are possible social signals include 'yawning' (as described by Garrick *et al.* 1978) and 'ear flapping' (Bellairs 1969).

Courtship and mating

Observations on courtship and mating were made from a hide in the mugger breeding enclosure at MCB. Often a head slap by a male

(which starts from the head up position) signalled approach and courtship. For example on March 9, 1978 at 0810 Beta head slapped, approached a female and mounted. The female submerged, Beta moved away; the female surfaced near his head, jaw raised. Male approach prior to courtship was usually in the tail-up position, with the single caudal crests arched well out or slightly out of the water. In one instance following a head slap geysering was observed as described by Garrick *et al.* (1978) — "a stream (spout) of water about 10 to 20 cm in height resulting from a release of air from the external nares while the snout is just under the surface of the water." Beta was heard roaring as in Garrick *et al.* (1978) prior to a courtship sequence.

During courtship, circling, bubble blowing and raising and touching jaws was observed. On 18 January 1978 at 1017 (following a head slap) Beta swam to tank centre in the tail up position, nudging a female's back with his head. The female raised her jaw, circled, bubbled, submerged. Beta raised his jaw, hissed, submerged. Female raised her jaw, both submerged for 5 minutes. Figure 2 provides a summary of these behaviours.

Females were observed bubbling at times other than during mating. Bubbling is perhaps a female courtship signal. Sometimes it was associated with a cough. Female mugger occasionally head slapped, as do *A. mississippiensis* (Garrick *et al.* 1978) and were twice observed to roll over in the water, exposing the belly as reported by Cott (1961) for *C. niloticus.*

During a courtship sequence on 14 January 1978 from 0855 to 1010 am a female mugger was observed repeatedly mock biting (Garrick and Lang 1977) the male's head. When the male mounted the female the pair submerged and mating progressed while fully or partially submerged, often surfacing and submerging alternately. Copulation lasted from five to fifteen minutes. During courtship and mating a high

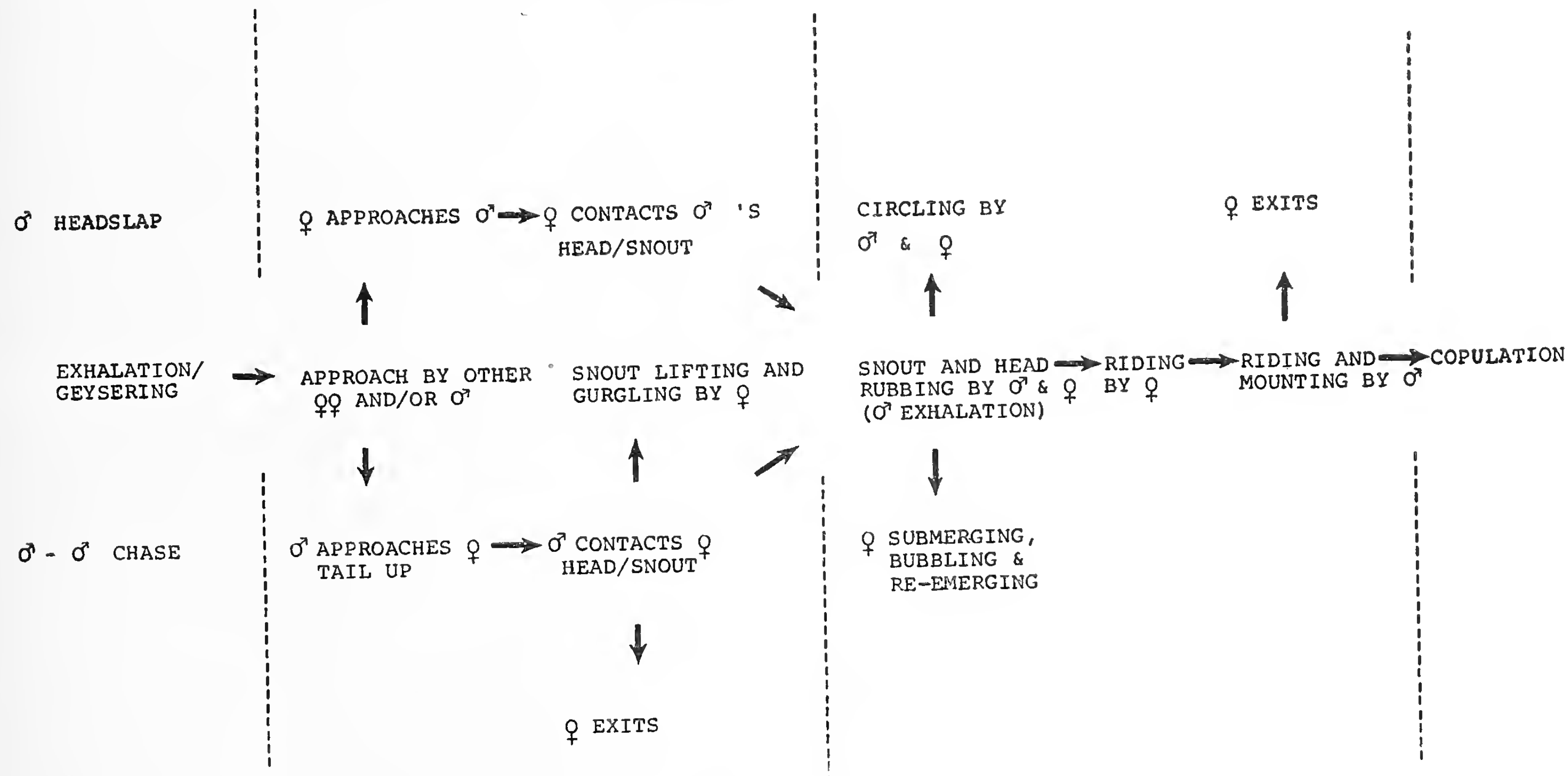


Fig. 2. Summary table of mugger reproductive behaviour as observed at Madras Crocodile Bank (after Garrick and Lang 1977).

degree of tolerance was shown toward other animals. Adult females and a sub-adult male were seen circling, nudging and in intermittent physical contact with a pair during courtship on several occasions. Courtship and mating were always observed in water though Yadav (1969) records copulation on dry land at the Jaipur Zoological Gardens.

On several occasions during courtship the throat glands of females in the head raised posture were briefly everted and withdrawn. It is possible that the scent glands function in some stimulatory capacity during pre-mating courtship. Prater (1933) reports that the scent glands in the throat and vent secrete a brownish liquid with a musty odour. He feels that the secretion is most active during the mating season and postulates that its release in the water enables individuals to find each other. This secretion has been observed as a waxy brown substance but seems to have very little detectable odour.

Dharmakumarsinhji (1947) made the first observations on breeding of wild mugger. He described the tail up and head emergent posture of the male and head up posture of the female prior to copulation. His observations agree with those of the authors, including the submerging, re-emerging cycle seen during copulation.

Nest construction and egg laying

Nesting females were observed at MCB. On 14 February 1979 on arrival at the breeding enclosure at 2100 a $7\frac{1}{2}$ year old female was seen lying on her freshly dug nest. At 2130 p.m. an egg (the last of her clutch) was expelled with a prolonged grunt. After laying the female inserted both feet into the egg chamber and gently pushed the entire clutch to the back of the cavity of the L-shaped hole (Figure 3). For this manoeuvre and while nest packing the tail was used for support (Whitaker 1979 c). She then began a slow

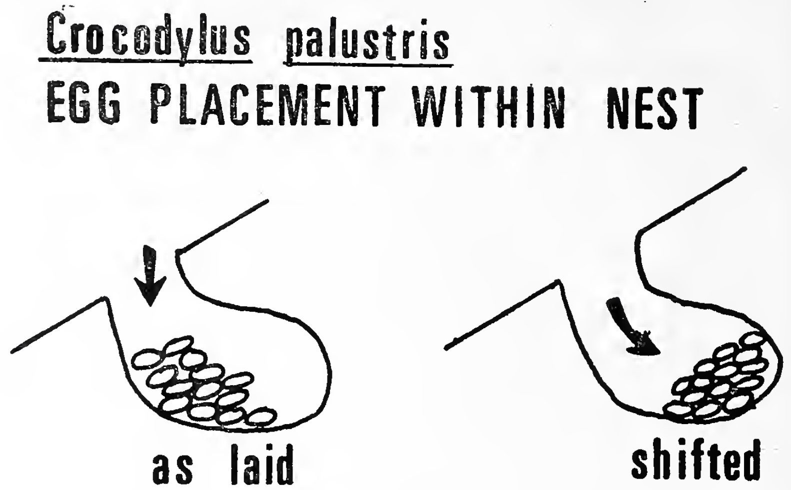
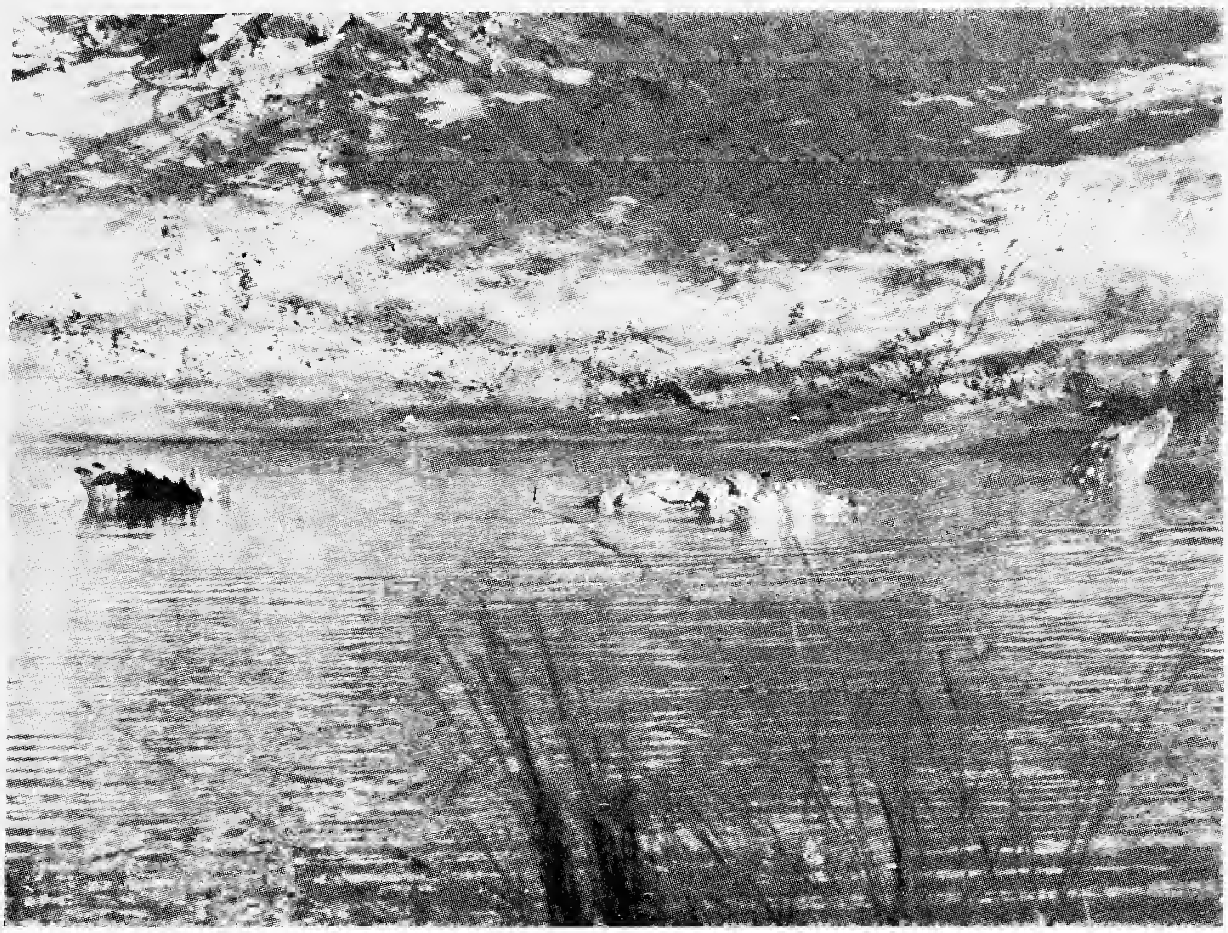


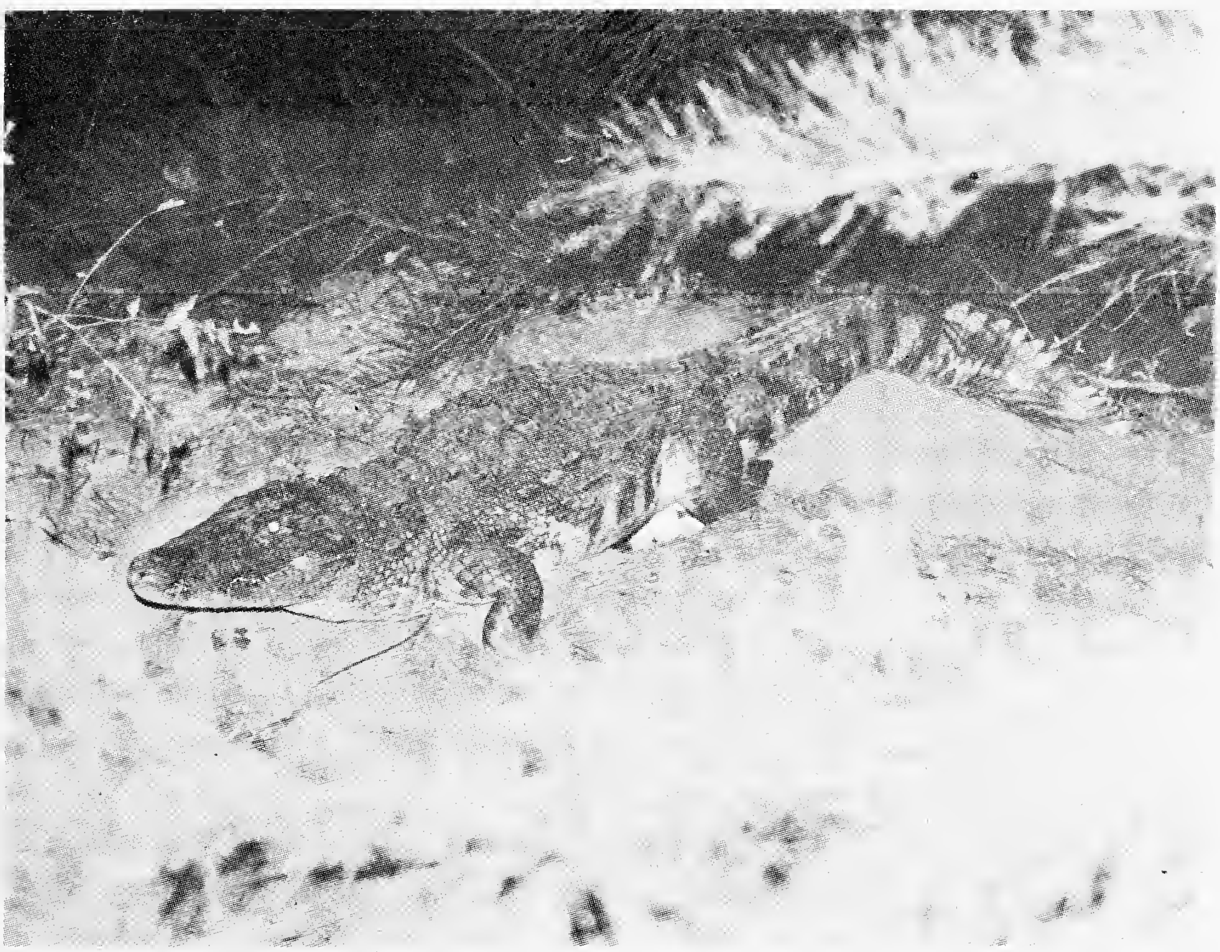
Fig. 3. Cross-section of mugger nest showing position of eggs before and after female shifts them with hind feet.

scratching with alternate movements of her hind legs, gently pushing sand into the nest hole. Sand was scraped over the nest and then periodically packed by treading with the hind feet (Figures 7 and 8). At 2210 she started turning on her nest, making seven full clockwise circles, completely flattening the nest area.

During wild egg collection programmes in 1975 and 1976, field study and surveys, over 50 wild nests were observed. Tables 5 and 6 give some of the physical characteristics of the nests. Hole length apparently corresponded to the length of the female mugger's hind leg. In most nests the soil at the egg cavity level was damp.

Locations included artificial reservoirs without shade, small, densely vegetated streams, and tidal lagoons (Whitaker and Whitaker 1975, 1979; Choudhury *et al.* 1979). At Amaravathi Reservoir the tracks of a mugger were followed into a hilly scrub forest over 1 km from the reservoir to where a 2.4 m female was found (Whitaker 1976 b). She later nested here (B.C. Choudhury, in litt.) but unsuccessfully, as the soil was too shallow. This





Above: Male mugger with arched tail approaches receptive female during courtship.
Below: Female mugger at Madras Crocodile Bank laying eggs.

PLATE II

Above: Female mugger scraping sand over nest site.
Below: Female mugger packs the finished nest by treading with hind feet.

unusual nesting behaviour was postulated to be due to the excessive human disturbance in the area. (Before protection, 90% of the eggs were taken each season by herdsmen and firewood collectors). At Amaravathi, nine out of eleven nests were situated on slopes facing east.

At Amaravathi, Kilikudi and Sathanur trial nest holes were a common feature near nests. *C. palustris* usually digs one or more trial nest holes before the final egg chamber. At Vakkaramari a female was seen making a trial nest in daylight and 2-3 trial nest holes were found for each nest (Whitaker 1974).

TABLE 5

DATA ON 50 WILD MUGGER NESTS IN TAMIL NADU

Hole length (cms)	Hole width (cms)	Distance from water	Height above waterline (m)	Layer of sand/earth covering eggs (cms)
35-56	22:14-31	10 m:1 m-2 km	6.2:1.5-10	19.5:13-26

TABLE 6

SOIL TYPE AND SHADE AT 59 WILD MUGGER NEST SITES (% NESTS)

Gravel/sand	Sand	Black clay	Loamy soil
37	34	17	10
Humus	**Unshaded**	**Partly shaded**	**Fully shaded**
1.7	86	7	7

An MSP investigator, V. Natesan observed a wild female mugger nesting at Vakkaramari, Tamil Nadu at 0630 on 15 March, 1976. She faced up the embankment and, eyes closed, made frequent straining movements as the eggs were deposited. She then started scraping soil forward with the front feet, turning while doing so. She continued scraping soil from the excavation back into the hole using her hind feet. She then flattened the site with her belly and lay still on the nest for a further fifteen minutes. She finally appeared to notice Natesan's close presence and entered the water, watching from 10 m. out as the investigator checked the nest (Whitaker 1976 a).

Clutch and egg size

Mugger lay 25-30 eggs; details of clutch sizes in different localities are given in Table 7. Clutch sizes were similar in north and south Indian nests. Although not adequately quantified it has been observed that clutch size is closely related to the size of the female. The average size of 340 eggs from wild nests in South India was 7.40 x 4.70 cms and weighed an average of 128 gms, closely corresponding to captive bred specimens eggs measured at MCB.

TABLE 7

CLUTCH SIZES OF MUGGER NESTS

Place	N	Clutch size x:range
Sathanur Reservoir, Tamil Nadu	5	27:17-35
Amaravathi Reservoir, Tamil Nadu	11	31:26-35
Vakkaramari, Tamil Nadu	3	32:18-46
Kilikudi, Tamil Nadu	3	19:16-21
MCB (8 females)	43	24: 8-39
MCB (1 female)	6	25: 8-33
Hiran Lake, Gujarat	2	25
Powai Lake, Maharashtra	1	17
Jaipur Zoo, Rajasthan	5	32:22-41
Total	79	26: 8-46

(Whitaker 1974, 1979 a, 1977; Whitaker and Whitaker 1975; 1977 b; Prakash 1971).

Incubation period and nest temperature

In captivity mating begins about two months before the first egg laying, suggesting a developmental period of 40-60 days. Incubation of mugger eggs averages about 2 months, details of captive incubated clutches are given in Table 8 which shows a slightly longer duration for nests in South India.

TABLE 8

INCUBATION PERIODS OF MUGGER NESTS

Place	N	Incubation period (days) $\bar{x}$: range
South India (wild)	20	67:41-80
South India (MCB)	33	68:41-85
North India (wild)	1	74
North India (Jaipur Zoo)	5	54:44-68

(Whitaker 1978, 1979 a, 1980; Whitaker and Whitaker 1975; Prakash 1971).

Nest temperatures in wild nests in South India ranged from 18°C in the early morning to 35°C in the early afternoon. In 1980 the overall nest temperature average at MCB was 31.3°C for the four months of February-May.

Nest losses

Of the 59 nests observed in the wild, 39% were collected for hatching in captivity, 36% were raided by humans for food, 15% hatched naturally, 3% spoiled, 5% were destroyed by predators and 1.5%, i.e. one nest, was destroyed by the female crocodile.

Multiple clutches per season

When double clutching was first observed at MCB in 1976 in a 19 year old female (Nova) it was thought to be exceptional or aberrant behaviour. Since then however, the laying of two clutches per season has become the norm for 6 females. Table 9 illustrates the details of the multiple nesting which occurred in 1979 and 1980. Clutch size and hatching success were slightly lower in 'B' nests. 'A' nests took an average of 5 days less incubation time, corresponding to lower temperatures prevailing during the 'B' nest incubation period. (Fig. 4).

TABLE 9

MUGGER DOUBLE CLUTCHING DATA AT MCB (MEANS FOR 1979 AND 1980 SEASONS)

N	$\bar{x}$ clutch size A nests	$\bar{x}$ clutch size B nests	$\bar{x}$% hatching success A nests	$\bar{x}$% hatching success B nests
22	29.2	23.6	59.1	47.0

N	$\bar{x}$ incubation period A nests	$\bar{x}$ incubation period B nests	$\bar{x}$ no. days between A & B nests
22	65 days	70 days	41

(Whitaker 1980)

Double clutching at MCB may be a result of the combination of high temperatures and high feeding rates. There seem to be three possibilities which might explain the phenomenon :

a) single mating with arrested development of second clutch
b) single mating and storage of sperm
c) double mating.

Sporadic mating of mugger was observed late in the season (March/April) but no peak similar to the December activity was noted. While the period of egg development in first and single clutches appears to be about 60 days there was an average of only 41 days between first and second nests. There is no

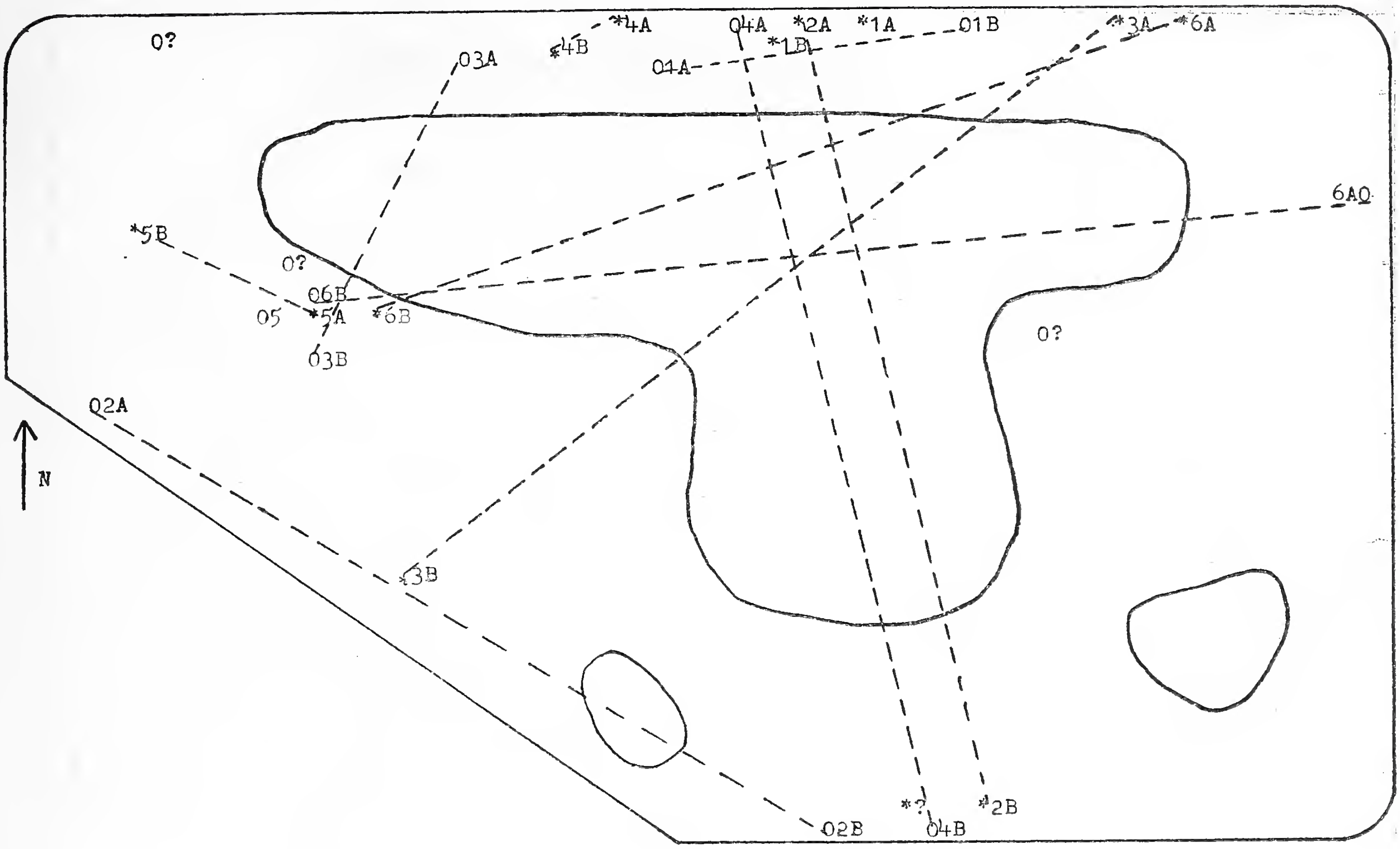


Fig. 4. Nest site selection by double clutching mugger in the Madras Crocodile Bank breeding enclosure. Dotted lines illustrate the tendency for widely separated site selection by individual females.

evidence of double clutching in wild mugger. Tribal inhabitants of crocodile habitat have generally proved to be the most reliable informants on mugger habits and only once have these egg collectors (Poliyars at Amaravathi Reservoir) indicated that they had seen fresh nests later than the normal season. The implications of double clutching for commercial farming are obvious, whether it could be of some survival value for wild mugger is a matter for conjecture. The mean distance between A and B nests was 22.5 m, while nests of different females averaged only 5 m apart (Table 10).

Messel (pers. comm.) suggests that 'early' and 'late' nests of *C. porosus* in Australia may be first and second nests of the same animal. Graham (1968) noted that over 50% of mature male *C. niloticus* had motile semen for 6 months. In addition, 24% of females had two or more sets of enlarging ovarian follicles of greatly differing sizes. He suggests that maturation of one set of ova may be accompanied by development of another set, resulting in the production of two batches of eggs in one season. Graham's conclusion is that "the time sequence of events would permit an animal to breed twice." According to Cott (1961), fresh crocodile eggs were found during two periods of the year in northern Lake Victoria (Uganda): August and early September, and again in December and January.

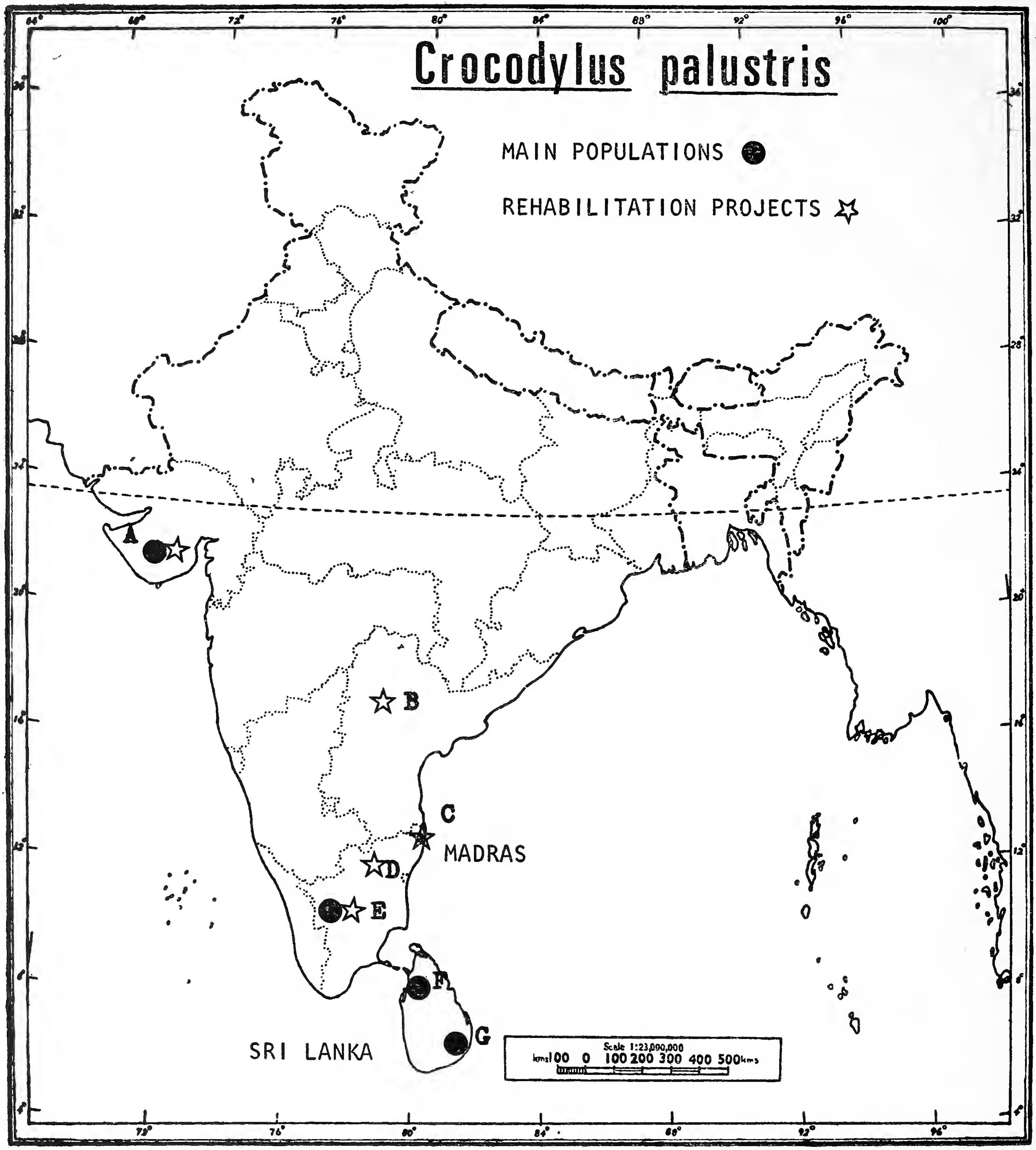


Fig. 5. Main *Crocodylus palustris* populations and projects.
A. Gir National Park, Gujarat. B. Hyderabad, Andhra Pradesh. C. Madras Crocodile Bank, Tamil Nadu. D. Sathanur reservoir, Tamil Nadu. E. Amaravathi reservoir, Tamil Nadu. F. Wilpattu National Park, Sri Lanka. G. Yala National Park, Sri Lanka.

Protection of nest

Nest defence has been observed both in the wild (S. Valliappan, pers. comm.) and in captivity (Whitaker and Whitaker 1977 a). At MCB and MSP nesting females defended nest sites and adjacent water areas and engaged in threat displays. They often thrashed their tails from side to side and made repeated serious charges at intruders, both crocodilian and human. If undisturbed the female will spend most of the incubation time at her nest and in the water near by. One female (Nova) fasted throughout incubation, while other younger females were less attentive to nests and did not fast.

Table 10

Distances between nests of double clutching MCB mugger

No.*	Female	1979 Distance from A to B nest (m)	1980 Distance from A to B nest (m)
1.	Karruppukann	1.90	17.40
2.	Chitra	32.00	9.50
3.	Stumpy	48.50	20.50
4.	Vijaya	5.80	32.00
5.	Nova	7.00	—
6.	Chidambaram	38.20	34.00
		Range and average 1.90-48.50:22.23	*Range and average* 9.50-34.00:22.70
		Distance to nearest nest (m)	Distance to nearest nest (m)
		Range and average 0.75-11.90: 3.57	*Range and average* 1.00-20.45: 6.61

* refers to map of MCB mugger breeding enclosure, Figure 4.

The role of the male *C. palustris* in nest protection has not been clearly established. A male at Ahmedabad Zoo ignored the female after copulation (David 1970). Similarly Yadav (1969) negates participation of the male in nest protection and defence of young. The male *C. niloticus* takes part in nest excavation and hatchling transport (Pooley 1974) as does the New Guinea crocodile (Lang, in press).

Hatching, release and transport of young

The female at MSP was observed at 0100 on 22 May 1978 excavating her nest with her front feet and head, leading 6 hatchlings to the pond 6 m, away, and communicating with them through grunts. She later excavated 5 more young. The female and hatchlings were heard calling sporadically all night up to 0500 (Whitaker 1980).

At 0900 the female chased the keeper from the enclosure. She pushed hatchlings out on to the palm leaves outside the pool with her snout. RW picked up a hatchling and on hearing its distress cry the female charged and bit the tree behind which he stood.

At 0950 the male was with the hatchlings in the main pond and the female in the adjacent pond. The female picked up a hatchling in her mouth and carried it to the main pond, shaking it out of her mouth where the other hatchlings were grouped (J. Vijaya, pers. comm.).

At 1010 she went again to her nest (possibly in response to a call) and dug with her front and (less often) hind feet. She moved clockwise over her nest, sometimes putting her nose in and biting clods of earth.

An egg was removed with the jaws, jerked back, and gently punctured by the front teeth. The hatchling slipped into the buccal pouch, squirming. She brought it, tail visible between her teeth, to the pond. It was observed that the hatchlings spent the first day almost entirely on dry land.

At 1100 another hatchling was picked up at the nest and brought to the same spot next to the pond.

Bone (1943) reports hearing baby mugger calling for "several days" from inside a nest. Neill (1971) reports that the grunt or distress cry of a juvenile will summon an adult but dismisses as folklore the idea that the mother crocodile responds to the call of the hatchlings and digs them out. Campbell (1973) discusses the probable significance of hatchling vocalization and its importance in attracting the mother at hatching time.

TABLE 11

VERNACULAR NAMES OF MUGGER

Language	Place	Vernacular name(s)
Urdu	Pakistan	Baghori, maggar
Hindustani	North India	Maggar mach
Bihari Hindi	Bihar	Bocha
Bengali	West Bengal	Kumeer
Tamil	Tamil Nadu	Mothalay
Telugu	Andhra Pradesh	Mosalay
Kannada	Karnataka	Mosalay
Singhalese	Sri Lanka	Hale kimbula, gette kimbula

Creche formation and defence of young

At MSP 13 hatchlings remained in the group or creche initially formed by the female for two months. They stayed with the male and female for 12 months through the next breeding season and no aggression toward the young on the part of either was observed. Groups of hatchlings were reported several times by fishermen and others and one creche group of 17 mugger hatchlings was found at Kedarhalla (Whitaker and Whitaker 1976).

At MCB during capture of hatchlings from an undetected nest, a mature male and female and a sub-adult male made repeated lunges and charges at the keepers and demonstrated a fierce defence of the hatchlings.

Both females and males respond to the juvenile distress cry. At MSP a hatchling was held near the enclosure and its distress cry brought a female charging out of the water and almost over the 1.5 m wall. Wild mugger, apparently of both sexes, responded to mimicked distress cries by approaching, leaving the water and charging.

Reddy (1978) reports 15 hatchlings eaten by the parent male and female at Indira Gandhi Zoological Park. This behaviour could have resulted from stress in confined quarters.

Conservation

MCB has been established with help from the World Wildlife Fund, New York Zoological Society, Tamil Nadu State Government, West German Reptile Leather Association and MSP Trust. It is self sustaining by tourism, and is a trust for the breeding, rearing and supply of live crocodiles for restocking and captive breeding programmes in India. Since its beginning in 1974 the Bank has accumulated breeding stock from captive sources, reared 250 mugger from wild collected eggs and produced 1100 mugger from captive breeding. 500 juvenile mugger (mostly one to two year old) have been supplied to several state governments for rearing and/or release.

The UNDP /FAO/Government of India crocodile programme has resulted in the formation of 10 protected habitats specifically for crocodilians, with 4 states involved in egg collection, rearing and release projects. At present about 800 mugger are being reared for release mainly in Tamil Nadu, Gujarat and Andhra Pradesh. To date about 650 have been released in separate habitats.

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MORPHOLOGICAL STUDIES ON THE SYCONIA OF *FICUS BENGALENSIS* LINN.[1]

R. INDRA[2]
AND
K. V. KRISHNAMURTHY[3]

(*With four text figures*)

The morphology of the syconia of *Ficus bengalensis* collected during July and November has been studied. There are male, female and gall flowers in syconia of both months but in July syconia two types of gall flowers are observed. The first type of gall flowers are smaller and enclose species of *Blastophaga,* while the second type are larger and enclose wasps which resembled species of *Apocrypta.* Unlike other species, the male flowers are not restricted to the proximity of the ostiole but are found here and there throughout the floor of the syconium. The results are discussed in relation to the previous observations on other species of figs.

INTRODUCTION

The genus *Ficus,* commonly known as the Fig, is characterised by the specialised type of inflorescence called Syconium (or Hypanthodium) which develops into a compound fruit. Because of their peculiar morphology, the syconia of figs have attracted the attention of a number of researchers who have studied their constitution, development and pollination biology (Galil and Eisikowitch 1968a, 1968b, 1969, 1974 and Galil and Yehudit Snitzer Pasternak 1970, Johri and Konar 1955, 1956). Special attention has been paid especially to the pollination biology of the figs and their pollinating insects like species of *Apocrypta, Blastophaga* and *Sycophaga.* A careful review of the previous literature indicates that not much work has been done on *Ficus bengalensis* L. which is a common species in India.

There also exists a lot of variations and confusions regarding the occurrence, location and distribution of the male, female, neutral and gall flowers in the syconia collected at different periods of the year. The object of the present study is to investigate the morphology of syconia and its constituent flowers in *Ficus bengalensis.*

OBSERVATIONS

The sessile syconia occur in pairs in the axils of leaves. There are 3 rounded bracts which become quite prominent and spreading at the base of each syconium and these bracts are glabrous, coriacious at the maturity of syconia. The syconia when very young are green but change to orange colour after a long time only to become red at maturity. The mature fruits range from 17-20 mm in diameter. There is also a change in shape of the inflorescence from the triangular to the rounded shape during development.

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Ostiole : Each syconium has an ostiole at its free end (Fig. 2D). Its position could be made out as a circular mark. But the opening becomes very conspicuous only during the ripening of the syconia, not only by an increase in its diameter but also by its rising above the surface of the syconia. The ostiole is lined internally by scales of different types.

There are about 10-14 hard triangular scales with rounded bases nearer towards the outer opening of the ostiole and these scales are so closely arranged that nothing could find its way out. But with the enlargement of the syconia these scales loosen to make an opening. These scales have their epidermal cells in the upper part drawn out into small elongated hair like structures whereas the basal part is devoid of these structures (Fig. 1A). Away from the external opening of the ostiole, are elongated hard scales which form the second category (Fig. 1B).

Flowers : The syconia consist of male, female and gall flowers. Of the two crops of syconia collected, one in November and the other in July, we could observe two differences: (1) the number of male flowers in the syconia collected in November is slightly more than that of the other. (2) In the syconia collected in July a few quite unusually large gall flowers along with the other usual type of flowers are observed.

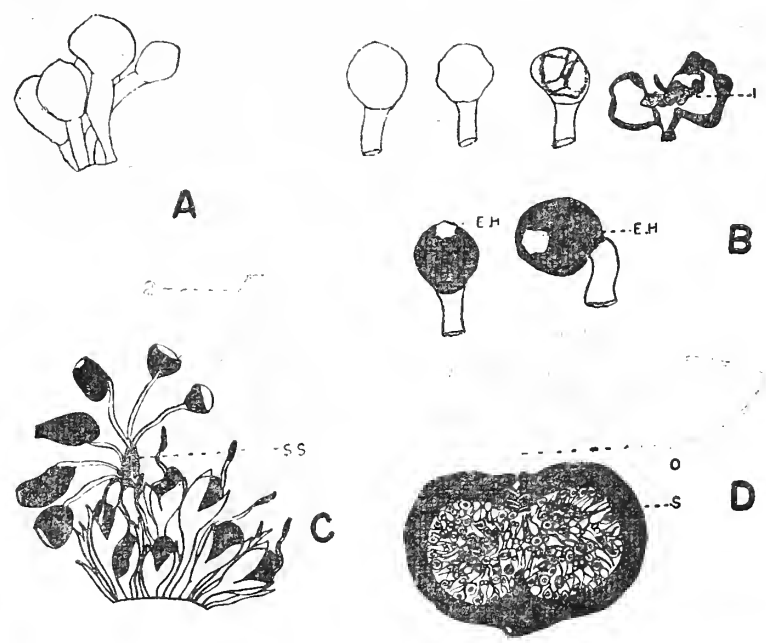

Fig. 2. A— Group of exceptionally large gall flowers. B — Stages in the development of exceptionally large gall flowers.
Abbreviations: E. H. — Exit hole, I — Insect. C — A group of female flowers forming Synstigam (SS). D — L.S. of Syconium. O — Ostiole, S — Staminate flower.

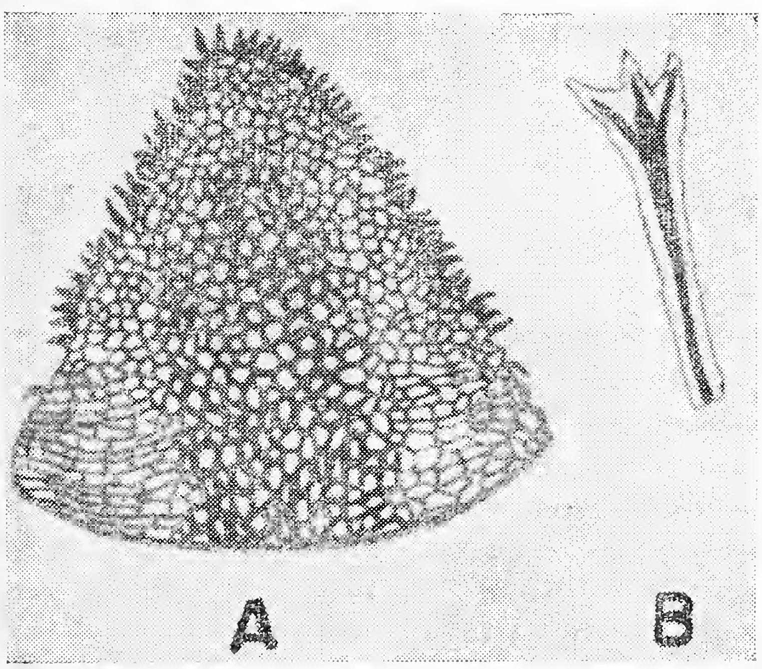

Fig. 1. A — Triangular scale found at the ostiolar region. B — Scale found away from the external opening of the ostiole.

(a) Male flowers : Male flowers are distributed here and there throughout the floor of the syconia (Fig. 2D). The number of male flowers per syconium is considerably less when compared to that of the female and gall flowers. All the male flowers are more or less of the same size. Each flower is bracteate and pedicellate, the pedicel being very long. Three perianth lobes arise at the end of the pedicel, enclosing the single stamen (Fig. 3A). The perianth is polyphyllous with imbricate aestivation. Each flower has a short, thick filament dilated at the apex

where the dithecous anther is embedded along its vertical thecae. The anthers open by longitudinal slits.

(b) Female flowers: The female flowers are of the following types: (1) Nearly half the number of female flowers of the syconium are sessile or almost sessile, with comparatively long styles (Fig. 3B). All these flowers are well developed. The length of the style varies from 2-3 mm. These flowers are bracteate with 3 polyphyllous and imbricate perianth enclosing the ovary at its base. Style is lateral. (2) The second type of flowers are pedicellate and have comparatively shorter styles (0.5-1 mm), (Fig. 3C, D). All intermediate forms with respect to style length are found. All these flowers have the same number of free perianth lobes enclosing ovaries with lateral styles. In this second category a few flowers are underdeveloped. These flowers in whose ovary parts the insects lay their eggs, hatch and develop into adults which escape through apical pores made by them on the ovary. As these different types of female flowers intermingle, the styles of these flowers become interlaced and stuck together, especially at their stigmatic level forming a compound or syn-stigma (Fig. 2C).

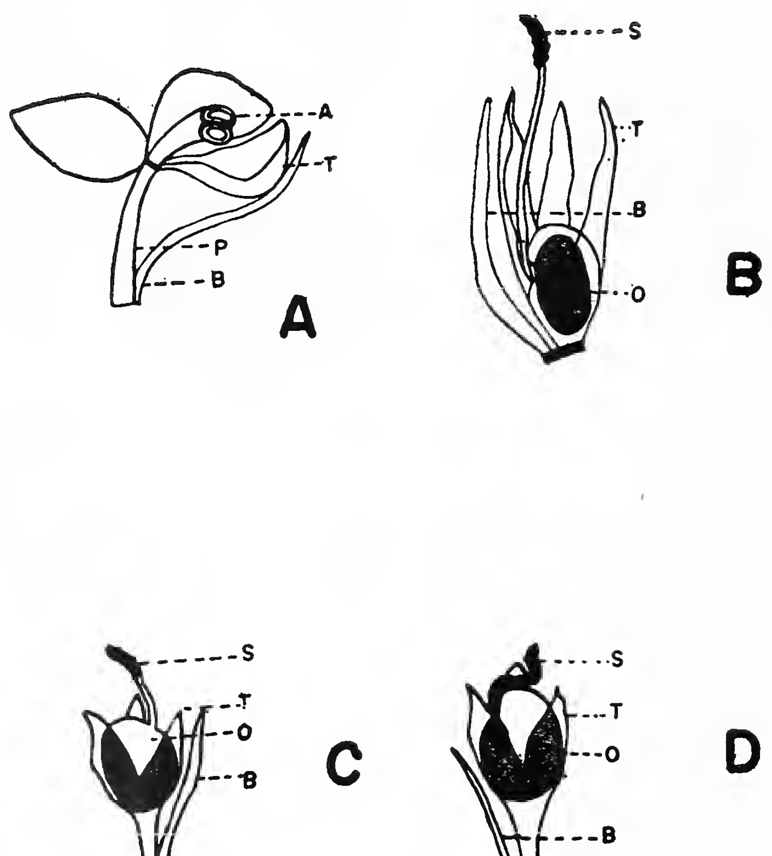

Fig. 3. A — Staminate flower.
Abbreviations: A — Anther, B — Bract, P — Pedicel, T — Tepal.
B — Sessile and long styled female flower.
Abbreviations: B — Bract, O — Ovule, S — Stigma, T — Tepal.
C & D. — Pedicellate and short styled flower.
Abbreviations: B — Bract, O — Ovule, P — Pedicel, S — Stigma, T — Tepal.

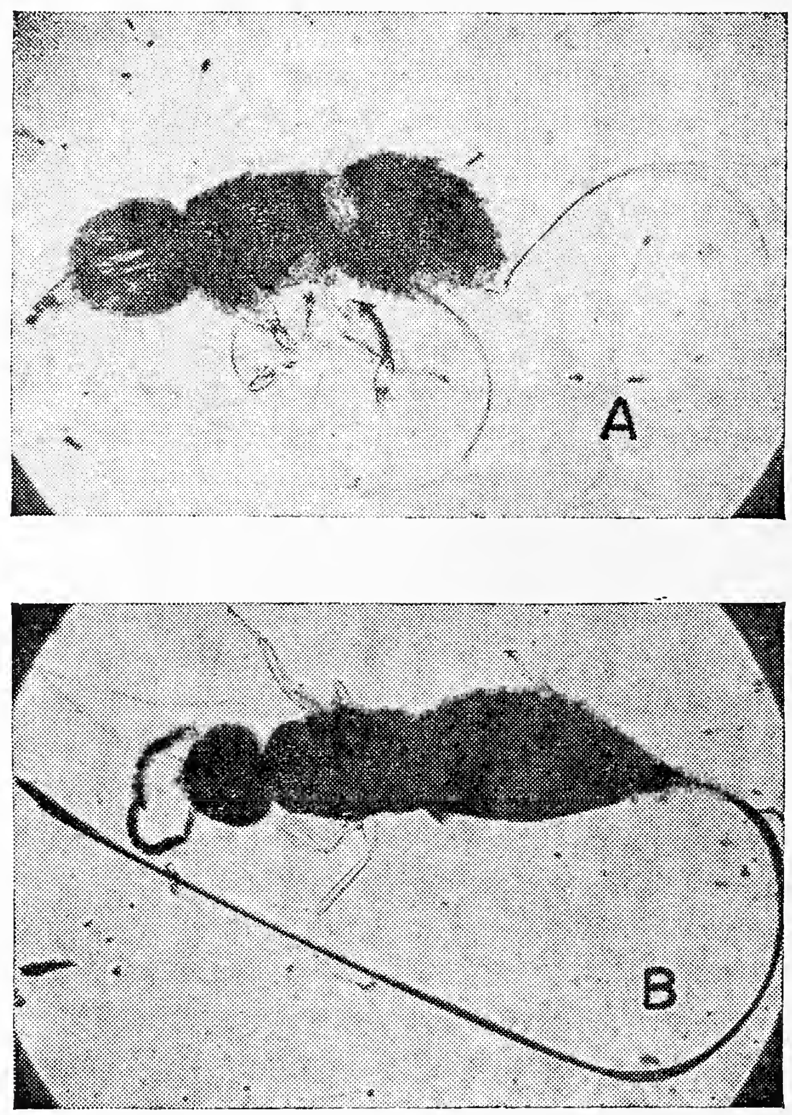

Fig. 4. A — *Blastophaga quadruticeps* — Adult insect. B — *Apocrypta* sp. — Adult insect.

(c) Unusually large gall flowers : In syconia collected in July a variable number of large, very distinct gall flowers are found in addition to the usual sized gall flowers (Fig. 2A). They are without perianth and largely distinct from other flowers in having a more or less spherical upper part borne on a hard stalk. The hardness is evident in such flowers even at younger stages of development. As they develop (Fig. 2B), their colour changes from whitish to pale brownish and the outer surface of the flowers becomes slightly crinkled. They all enclose insects which at maturation escape out through an opening, much in the same way as in the other type of gall flowers. After the insect leaves the flowers, the flower becomes still harder and the colour becomes dark brown (Fig. 2B).

Gall insects : The insects collected from the syconia were found to be of two different types. One type of insect resembles *Blastophaga quadruticeps* (Fig. 4A) where sexual dimorphism is exhibited. The males are wingless whereas the females are winged with a long filament at the posterior end. The other insect resembles the species of the genus *Apocrypta* (Fig. 4B) whose males do not have the filament. Careful studies indicate that the unusually large sized gall flowers harbour the metamorphic stages of *Apocrypta* while the other type of gall flowers seem to have *Blastophaga.*

Discussion

The distribution of male flowers in the syconium has been a matter of discussion in the past literature. In *Ficus religiosa* investigated by Johri and Konar (1955, 1956) there are 11-19 male flowers distributed nearer to the ostiole region of the syconium. In syconia of the same species (Galil & Eisikowitch 1968a), collected at Israel, there are only 9-12 male flowers, but their distribution is the same as in Indian syconia recorded by Johri and Konar (1956). In *Ficus syconiosus* also the male flowers are distributed nearer to the ostiole (Galil & Eisikowitch 1968b). In the syconia of *F. bengalensis* investigated at present, the male flowers are scattered throughout the floor of the syconium and are not restricted to the ostiolar proximity. This is true of syconia collected both during July and November. In November syconia there are more number of male flowers than in July syconia.

The present study is able to confirm the presence of different types of female flowers within the same syconium recorded earlier for other species of *Ficus.* The sessile long styled ones form the one extreme and the pedicelled short styled ones form the other extreme. All intergrades in stylar length could be observed. The present study confirms the earlier observations on other species that the long styled sessile flowers are generally the seed flowers while the pedicellate short styled ones invariably develop into gall flowers. The occasional development of short styled ones into fruiting stage and the long styled ones into gall flowers, indicates that there is no fundamental distinction between female and gall flowers, a fact already stressed by Johri and Konar (1956), and Galil and Eisikowitch (1968b) for other species.

The presence of two types of gall flowers is a significant point of discussion. One type of gall flower is found both in the July and November syconia, while the other is observed only in July syconia. The latter type is unusually large, whitish to start with but becoming brownish at maturity, has fairly long and thick pedicels, perianth lobes could not be detected in it. It also contains different

type of gall wasp resembling the genus *Apocrypta* while the other type of gall flower encloses *Blastophaga* species. Although the presence of more than a single gall wasp in the syconium of a few other species (see Galil and Eisikowitch 1968a) is recorded, as far as we are aware of, it has not been recorded in *F. bengalensis.* This complicates the pollination ecology of this species.

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DISTRIBUTION OF *DROSOPHILA* SPECIES AND THEIR DIVERSITIES IN THE TROPICAL RAIN FORESTS OF WESTERN GHATS[1]

H. S. PRAKASH AND G. SREERAMA REDDY[2]

(*With a text-figure*)

The studies on the Drosophilid fauna of the tropical rain forests of Western Ghats have revealed the occurrence of 40 species representing four genera namely *Drosophila, Scaptomyza, Phorticella* and *Leucophenga*. Majority of the species collected belong to the genus *Drosophila* while only three species belong to the latter three genera. The members of the genus *Drosophila* are shared by four subgenera namely *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha,* of which the former two include the major bulk of 98.6% of the total population. The analysis of *Drosophila* fauna has revealed six new species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagerholensis* and *D. gundensis;* and three new records namely *D. elegans, D. rhopaloa and D. grandis,* as well as several others which are not reported from plains of Peninsula indicating the diversity in the species composition.

The collection localities were found to vary a great deal in the composition and in the relative concentration of different species. Only two species namely *D. malerkotliana* and *D. nasuta* were found to be abundant at almost all the collection localities and can be adjudged as ecologically versatile. Another species *D. immigrans* which was not reported from the semiwild and domestic localities of Peninsular India was observed in large numbers in four of the eight localities indicating its preference to moist and humid climatic conditions. Similarly, *D. punjabiensis* which was occasionally reported from the semiwild localities was noticed in considerable numbers in three of the eight localities. Other species were found to be represented in low to moderate numbers.

The sympatric association and ecological dominance of the members belonging to *melanogaster* and *immigrans* species group of two different subgenera, *Sophophora* and *Drosophila* in the area under investigation, the wide spread and endemic characters of the *Drosophila* species and the finding of six new species as well as three new reports encountered in the collection are discussed.

INTRODUCTION

The Drosophilidae is a large family of flies of world-wide distribution. About half of the known species belong to the very large genus *Drosophila.* It is known to contain more than 1,300 biologically valid species (Bock and Parsons 1978). They have been categorised into nine subgenera namely, *Sophophora, Drosophila, Hirtodrosophila, Scaptodrosophila, Dorsilopha, Siphlodora, Sordophila, Phloridosa* and *Engiscaptomyza.* However, only the first four subgenera contain a substantial number of species which are generally regarded as representing major bursts in speciation. Parallel with the development of genetical and

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evolutionary knowledge, taxonomic studies in the genus have advanced a great deal in the past few decades. As a result of this, several new species are constantly being described and the total size of the genus must consist of at least 2,000 species (Stone *et al.* 1960).

The Indian sub-continent with its diverse climatic and varied physiographic conditions provides large number of natural environs for colonization by the members of the genus *Drosophila.* However, a vast area of great ecological interest still awaits exploration. Reference to literature reveals that very little information is available on several aspects of *Drosophila* biology. Inspite of the striking progress made during the last few years (Parshad and Paika 1964, Parshad and Duggal 1965, 1966; Rahman and Singh 1969, Gupta and Ray-Chaudhuri 1970a, b, c; Singh 1970, 1972; Jha, Mishra and Singh 1971, Reddy and Krishnamurthy 1971, 1974, 1977; Vaidya and Godbole 1971, 1972, 1973, 1976; Godbole and Vaidya 1972; Ranganath and Krishnamurthy 1972; Siddaveere Gowda and Krishnamurthy 1972; Gupta 1973, 1974; Siddaveere Gowda *et al.* 1977 and Gupta and Singh 1977), information pertaining to the occurrence and the pattern of distribution of Drosophilid fauna in various parts of the country is not clearly understood. Judging from the reports of *Drosophila* taxonomy from other parts of the world, it appears that the number of species reported thus far from the Indian sub-continent is too small and does not reflect the true picture of *Drosophila* fauna. Until recently almost nothing was known of *Drosophila* inhabiting the tropical rain forests of Western Ghats extending from river Tapti to Cape Comorin (Peninsular India). In view of this we have chose the unexplored areas of the tropical rain forests of Western Ghats to get an insight into the diversity in *Drosophila* species, their relative abundance and their dependance on the rain forest type of vegetation as well as their ecodistributional pattern of different species inhabiting this region.

Materials and Methods

Drosophila collections were made during the monsoon periods of 1976, 1977 and 1978 from eight localities of the tropical rain forests of Western Ghats (Fig. 1). The general ecogeographical features of the area under investigation as well as the topographical features and the climatic factors of eight localities are briefly described below.

Ecogeographical features of Western Ghats

Western Ghats extend along the western side of Peninsular India, from the mouth of the river Tapti to Cape Comorin. They include the humid belt of hilly or mountainous country. The vegetation of this part of the country is influenced more by the abundance and distribution of the seasonal rainfall than the atmospheric temperature. The western side of the Western Ghats is on the threshold of southwest monsoon and receives the maximum rainfall whereas, the eastern side lies in the rain-shadow area of the hills. The main types of soils met with in the Western Ghats are red, laterite, and black soils. Shifting cultivation, grazing and indiscriminate lopping have resulted in the destruction of some of the virgin forests, which now survive only in some of the inaccessible mountain summit areas. Introduction of plantation crops like tea, coffee, rubber and extension of teak in southern regions of Western Ghats and cultivation of *Eucalyptus* especially in Nilgiri have also resulted in the destruction of large virgin

Fig. 1. Map of Peninsular India illustrating eight localities of Western Ghats from which *Drosophila* collections were made (△).

forests. Construction of large number of hydro-electric projects resulting in the submersion of catchment areas have further accelerated regressive changes in the forest flora of the region.

The most outstanding feature of Western Ghats is the development of the tropical rain forests prominently seen on the windward side of the southern part, usually between the altitudes of 500 to 1500 m. The humid tropic belt of Western Ghats possesses the following forest types : 1. tropical moist deciduous, 2. tropical semievergreen, and 3. tropical evergreen. According to Richards (1952) (cf. Subramanyam and Nayar 1974), tropical rain forests have no marked summer and winter seasons, but only wet and dry seasons. The seasonal changes of temperature are quite insignificant in relation to the seasonal variations in rainfall. The forests are characterised by multistoried canopies of vegetation and the various synusiae like : 1. trees and shrubs, 2. herbs, 3. climbers, 4. stranglers and 5. epiphytes. The ground layer and the trees themselves are carpeted with mosses, ferns, orchids and lichens and thus form a characteristic biological spectrum providing large number of natural environs for the colonization of the members of the genus *Drosophila.* Subramanyam and Nayar (1974) have divided the Western Ghats into four phytogeographical regions, namely : 1. the Western Ghats from the river Tapti to Goa, 2. the Western Ghats from the river Kalinadi to Coorg, 3. the Nilgiri and 4. the Anamalai, Palni and Cardamom Hills.

1. *Western Ghats from the river Tapti to Goa*

This botanical division is dominated by mountain chains, rising to 1000 m abruptly within a short distance of 2-3 km and is characterised by deep ravines, canyons and flat-topped spurs intersected by valleys. It receives the full blast of the monsoon rainfall from June to September. The vegetation consists of dry deciduous, moist deciduous and evergreen forests, However, Qureshi (1965) remarks that the evergreen forests occurring in this region are not typical tropical evergreen forests. Hence they are classified as montane subtropical evergreen forests. *Drosophila* collection was made at one locality namely Khandala Ghats.

Khandala Ghats are located between Poona and Bombay, situated at 19° 0 'N latitude and 73° 10'E longitude. The temperature ranges from 14°C to 30°C, with a relative humidity of 65% to 80%. The average annual rainfall is about 3,950 mm. Collections were made at various altitudes of 760-790 m.

2. *Western Ghats from the river Kalinadi to Coorg*

This region is marked by a series of breaches in the mountain wall by the rivers Kalinadi, Gangavali Bedti, Tadri and Sharavati. The access to the interior is not easy, since the valleys are surrounded by deep gorges 3-5 km across and 300 m deep. The entire area is hot and humid. The heavy rainfall favours thick tropical forest growth with best teak plantations in the upper evergreen zone. The main types of vegetation observed here are scrub, moist deciduous and evergreen forests. Five localities namely Sahyadri Hills' range, Agumbe, Jagra Valley, Bababudangiri and Kemmangundi Hills' range and Nagarhole were chosen to analyse the *Drosophila* fauna. The brief description of these localities are as follows :

i) *Sahyadri Hills' range* extends towards the western side of Shimoga and situated at 13° 45'N latitude and 74° 48'E longitude. It has an average annual rainfall of about

2,978 mm. The temperature ranges from 18°C to 32°C, with a relative humidity of 60% to 81%. The altitudes of the collection sites range from 590 to 710 m.

ii) *Agumbe* is located to the southwest of Shimoga and situated at 13° 18'N latitude and 74° 38' E longitude. It receives very heavy rainfall with an annual average of 8,275 mm. Because of the heavy rainfall it is called *'Cheera Punji'* of South India. This has contributed to the growth of dense forest in the locality. The temperature ranges from 17°C to 31°C with a relative humidity of 70% to 90%. The altitudes of the collection sites range from 760 to 800 m.

iii) *Jagra Valley* is situated at a distance of 50 km to the west of Chikmagalur and located at 13° 10'N latitude and 75° 45'E longitude. It has an average annual rainfall of about 2,160 mm. The temperature ranges from 16°C to 30°C, with a relative humidity of 75% to 90%. Collections were made at various altitudes of 700-780 m.

iv) *Bababudangiri and Kemmangundi Hills' range* is a picturesque place of Western Ghats situated at 13° 17'E latitude and 75° 45'E longitude. The average annual rainfall is about 2,856 mm. The temperature ranges from 12°C to 32°C, with a relative humidity of 76% to 93%. The altitudes of the collection sites range from 1000 to 1600 m. Many of the hills are covered with heavy forests, while valleys and ravines produce luxuriant trees known for their great height and size.

v) *Nagarhole* is about 75 km to the west of Mysore City and situated at 12° 18'N latitude and 70° 09'E longitude. It has an average annual rainfall of 1,610 mm. The temperature ranges from 18°C to 30°C with a relative humidity of 55% to 80%. The altitudes of the collection sites range from 760 to 790 m.

3. *The Nilgiri Hills*

Nilgiri forms a compact plateau with the highest elevation of 2,670 m at Doddabetta and dissected much-worn massif, with steep hills and rolling downs, interspersed with *shola* forests. The forest is evergreen, composed of tropical and sub-tropical vegetation. The *sholas* are characteristically filled with evergreen forests with thick undergrowth. *Drosophila* collection was made at one locality namely Kotagiri.

Kotagiri is about 25 km to the southeast of Ootacamund and situated at 11° 22'N latitude and 77° 05'E longitude. The average annual rainfall is about 1,524 mm. The temperature ranges from 12°C to 30°C, with a relative humidity of 70% to 85%. The altitudes of the collection sites range from 1400 to 1960 m.

4. *The Anamalai, Cardamom and Palni Hills*

The topography of this region is remarkably more complex than the Nilgiris. They have the highest peak of 2,695 m in the Peninsula. In the northwest, the hills fray out into long southeast-northwest ridges. The types of vegetation on these hills are dry deciduous type at the lower elevations with an annual rainfall ranging from 1600-2600 mm; and moist deciduous type between the altitudes of 500-900 m with a rainfall from 2400-3500 mm. The wet evergreen forest types are also seen on elevations ranging from 500-2500 m along the windward side of the Western Ghats, where the rainfall ranges from 2500 to 5000 mm. *Drosophila* collections were made at one locality namely Anamalai Hills.

Anamalai Hill range is situated at 10° 24'N latitude and 76° 40°E longitude. The

average annual rainfall is about 4,000 mm. The temperature ranges from 12°C to 30°C, with a relative humidity of 80% to 90%. The altitudes of the collection sites range from 800 to 2,400 m. The collections were made mostly in moist deciduous type and wet evergreen forests.

Collection methods

Drosophila collections were made at five sites in each of the eight localities except for Bababudangiri and Kemmangundi Hills' range where 12 sites were selected. The sites chosen are 5-10 km apart and have at least one element in common and that is shade from the direct sun rays. Collections were carried out by using 10 traps (250 ml milk bottles) at each site, enabling the comparison of quantitative differences among the sites to be made. The conventional bait such as fermenting banana fruit, a technique successful for most Indian species of the subgenera *Sophophora* and *Drosophila*, but less so for species of the other subgenera was employed. Occasionally, sweeping off foliage and leaf litter was made, which was found to be successful for the members of the subgenera *Scaptodrosophila* and *Drosophila*.

Bottles containing bait were tied up to the branches of trees and bushes in the vicinity of permanent water or moisture. Away from moist area, especially in dry weather, the yield of flies was consistently low. Members of the genus *Drosophila* have been shown to be very sensitive to desiccation and high temperature stresses (Parsons 1977), so that on sunny days flies are usually found in cool, damp shaded microniches. Bottles were collected after two days during cooler hours of the day. The collected flies were sorted out, categorized and number of each species was recorded. The individual females which could not be assigned to any taxonomic group were isolated and allowed to breed in separate vials with a standard *Drosophila* food medium. The progenies of such gravid females were used for detailed studies to assign them to their respective groups.

Observations

The occurrence, distributional pattern and the relative abundance of the species collected in each of the eight localities of four phytogeographical regions of Western Ghats are presented below :

1. *Western Ghats from the river Tapti to Goa*

Khandala Ghats : A survey of *Drosophila* fauna of this locality yielded a total of 2,660 flies comprising of 11 species representing four subgenera, *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha* of the genus *Drosophila*. The number of individuals of different species collected at five sites along with their respective altitudes are given in table 1. Of the 11 species collected, *D. malerkotliana* and *D. punjabiensis* were found to dominate the collections with a total of 777 (29.2%) and 698 (26.2%) flies respectively. *D. jambulina* and *D. nasuta* were next to them with 342 (12.9%) and 301 (11.3%) flies respectively. Two other species, *D. bipectinata* and *D. rajasekari* with 177 (6.7%) and 122 (4.2%) individuals respectively were found in moderate numbers in the collections. The above six species were noticed in almost all the sites scanned. While other species such as *D. takahashii, D. neonasuta, D. brindavani, D. krishnamurthyi* and *D. busckii* were less common and comprise only about 9.5% of the total flies collected.

TABLE 1

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN KHANDALA GHATS (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	760	770	780	790	
Subgenus: *Sophophora*						
D. takahashii	11	31	—	11	35	88
D. rajasekari	5	9	58	30	10	112
D. malerkotliana	254	157	206	102	58	777
D. bipectinata	73	38	—	46	20	177
D. punjabiensis	67	71	58	243	259	698
D. jambulina	37	14	120	82	89	342
Subgenus: *Drosophila*						
D. nasuta	38	68	41	80	74	301
D. neonasuta	—	20	—	33	9	62
D. brindavani	—	—	16	—	11	27
Subgenus: *Scaptodrosophila*						
D. krishnamurthyi	14	13	8	10	21	66
Subgenus: *Dorsilopha*						
D. busckii	—	3	1	6	—	10
Total	499	424	508	643	586	2660
Number of species	8	10	8	10	10	

2. *Western Ghats from the river Kalinadi to Coorg*

i) *Sahyadri Hills' range* : The population sample of this locality yielded a total of 1,531 flies comprising 10 species representing two subgenera, *Sophophora* and *Drosophila* of the genus *Drosophila.* The distributional pattern and the relative numbers of the species collected along with the altitudes of the collection sites are shown in table 2. The number of individuals of different species vary a great deal from one site to another. Of the 10 species collected, only two namely *D. malerkotliana* and *D. nasuta* with 678 (44.3%) and 433 (28.3%) flies respectively were found to dominate in all the sites forming more than 2/3 of the total flies trapped. Two other species, *D. anomelani* and *D. bipectinata* were also observed in almost all the sites with moderate frequencies of 109 (7.1%) and 88 (5.7%) individuals respectively. The remaining six species namely *D.takahashii, D. eugracilis, D. sahyadrii* sp. nov., *D. mysorensis, D. agumbensis* sp. nov. and *D. neonasuta* were less common and contribute only about 14.6% to the total population. A noteworthy feature of this locality is that there is a gradual transition of scrub type of vegetation to evergreen flora in east-west direction making the sites increasingly favourable for the colonization of *Drosophila.* This is reflected by the increase in the variety and the relative numbers of different species collected in east-west direction (table 2).

ii) *Agumbe* : The population sample of this locality is comparatively small, with a total of 1,170 individuals consisting of 12 species representing three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the

TABLE 2

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN SAHYADRI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	590	620	650	690	710	
Subgenus: *Sophophora*						
D. takahashii	—	9	7	11	—	27
D. eugracilis	4	14	22	—	22	62
D. sahyadrii sp. nov.	6	—	—	—	3	9
D. malerkotliana	49	45	194	160	230	678
D. bipectinata	—	20	10	26	32	88
D. anomelani	11	24	24	19	31	109
D. mysorensis	—	6	1	21	12	40
D. agumbensis sp. nov.	25	—	12	2	18	57
Subgenus: *Drosophila*						
D. nasuta	47	60	58	86	182	433
D. neonasuta	1	—	—	3	24	28
Total	143	178	328	328	554	1531
Number of species	7	7	8	8	9	

TABLE 3

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN AGUMBE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	770	785	790	800	
Subgenus: *Sophophora*						
D. eugracilis	12	26	4	17	21	80
D. pseudoananassae	11	8	—	—	9	28
D. malerkotliana	105	85	53	27	69	339
D bipectinata	21	18	—	15	28	82
D. anomelani	13	41	29	22	35	140
D. montium	22	13	18	3	—	56
D. rhopaloa	3	21	—	4	15	43
D. agumbensis sp. nov.	15	—	8	10	—	33
Subgenus: *Drosophila*						
D. nasuta	57	48	33	65	75	278
D. neonasuta	16	14	9	11	18	68
D. grandis	—	—	—	—	2	2
Subgenus: *Scaptodrosophila*						
D. mundagenesis	4	1	8	3	5	21
Total	279	275	162	177	277	1170
Number of species	11	10	8	10	10	

genus *Drosophila.* The collection data along with the altitudes of the sites are shown in table 3. The low yield of flies from this locality was due to the disturbance caused by the heavy rainfall at the time of collection. Of the 12 species, only three, namely *D. malerkotliana* with 339 (29%), *D. nasuta* with 278 (23.8%) and *D. anomelani* with 140 (12%) individuals were found to dominate in all the sites scanned. The remaining nine species namely *D. eugracilis, D. pseudoan-anassae, D. bipectinata, D. agumbensis* sp. nov., *D. montium, D. rhopaloa, D. neonasuta, D. grandis* and *D. mundagenesis* were found in moderate frequencies and form the rest of the population sampled.

iii) *Jagra Valley* : Analysis of the *Drosophila* sample of 1,537 flies from this locality revealed the occurrence of 13 species representing only two subgenera, *Sophophora* and *Drosophila* of the genus *Drosophila.* The number of individuals of each species collected and the altitudes of the collection sites are shown in table 4. Nine of the 13 species observed, belong to the subgenus *Sophophora* and four to the subgenus *Drosophila.* Five species namely *D. malerkotliana* (289 or 18.8%), *D. immigrans* (232 or 15.1%), *D. anomelani* (220 or 14.4%), *D. mysorensis* (200 or 13%) and *D. nasuta* (184 or 12%) were found to be present in all the sites forming the major bulk of the total population with 73.3%. While the remaining species such as *D. jagri* sp. nov., *D. eugracilis, D. bipectinata, D. jambulina, D. gundensis* sp. nov., *D. neonasuta* and D. *nigra* were observed in moderate numbers in some sites contributing to the rest of the collection.

iv) *Bababudangiri and Kemmangundi Hills' range* : Analysis of the population sample

TABLE 4

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN JAGRA VALLEY (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	720	745	755	765	780	
Subgenus: *Sophophora*						
D. takahashii	—	22	24	3	10	59
D. jagri sp. nov.	16	11	—	—	19	46
D. eugracilis	—	27	—	24	19	70
D. malekotliana	49	29	57	77	77	289
D. bipectinata	20	—	35	3	14	72
D. jambulina	4	—	20	7	—	31
D. anomelani	44	46	39	47	44	220
D. mysorensis	65	29	35	37	34	200
D. gundensis sp. nov.	13	—	4	—	9	26
Subgenus: *Drosophila*						
D. neonasuta	44	38	46	49	7	184
D. neonasuta	20	26	—	18	38	102
D. immigrans	54	39	33	65	41	232
D. nigra	—	1	5	—	—	6
Total	329	268	298	330	312	1537
Number of species	10	10	10	10	11	

TABLE 5

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN BABABUDANGIRI AND KEMMANGUNDI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Altitude (in metres)	1000	1050	1250	1250	1250	1300	1325	1350	1375	1375	1500	1600	
Genus: *Drosophila*													
Subgenus: *Sophophora*													
D. takahashii	24	—	—	39	—	—	—	—	—	—	—	—	63
D. giriensis sp. nov.	18	—	45	—	18	—	—	13	50	13	—	—	157
D. suzukii	—	—	—	—	—	—	1	—	—	—	—	—	1
D. eugracilis	36	—	—	26	—	—	—	—	48	—	—	—	110
D. ananassae	—	—	—	—	—	—	—	8	—	—	—	—	8
D. bipectinata	—	—	—	—	9	—	22	—	17	—	—	—	48
D. malerkotliana	26	—	—	32	29	15	19	—	50	49	—	—	220
D. punjabiensis	—	—	17	—	—	—	—	—	8	—	—	—	25
D. jambulina	9	—	—	—	—	3	—	6	—	—	—	—	18
D. mysorensis	18	35	53	24	19	27	29	20	67	38	30	23	383
D. anomelani	21	25	—	—	—	—	—	—	—	—	—	—	46
D. rhopaloa	—	18	—	28	24	20	—	18	48	20	—	—	176
D. gundensis sp. nov.	—	—	—	—	—	4	—	—	—	4	—	—	8
Species 'U'*	—	—	—	—	—	—	—	—	—	—	—	1	1
Subgenus: *Drosophila*													
D. nasuta	65	38	68	26	46	10	44	29	72	20	38	30	486
D. neonasuta	—	—	—	—	4	—	—	—	8	—	—	—	12
D. immigrans	23	44	—	37	43	79	81	47	54	29	115	29	581
D. brindavani	—	—	—	—	—	—	6	—	—	—	—	—	6
Species 'N'*	—	—	—	—	—	—	—	—	—	11	—	—	11
Subgenus: *Scaptodrosophila*													
D. meijerei indicus	—	—	—	—	—	—	—	—	—	1	—	—	1
D. mundagenesis	37	16	—	—	—	—	—	—	—	—	—	—	53
Genus: *Scaptomyza*													
Scaptomyza elmoi	—	—	—	—	—	—	1	—	—	—	—	—	1
Total	277	176	183	212	192	158	203	141	422	185	183	83	2415
Number of species	10	6	4	7	8	7	8	7	10	9	3	4	

* Unidentified members of the genus **Drosophila**.

TABLE 6

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN NAGARHOLE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	760	765	780	790	790	
Subgenus: *Sophophora*						
D. takahashii	—	5	24	16	12	57
D. eugracilis	—	1	30	5	18	54
D. bipectinata	4	—	3	34	26	67
D. malerkotliana	62	61	81	118	227	549
D. punjabiensis	12	5	18	14	16	65
D. jambulina	5	19	34	32	35	125
D. kikkawai	—	—	19	7	14	40
D. anomelani	5	—	22	—	14	41
D. mysorensis	—	—	18	12	9	39
D. nagarholensis sp. nov.	1	—	7	3	5	16
Subgenus: *Drosophila*						
D. nasuta	19	36	91	56	95	297
D. neonasuta	—	42	50	69	42	203
D. repleta	—	—	4	1	3	8
Subgenus: *Scaptodrosophila*						
D. mundagenesis	—	—	5	1	1	7
D. meijerei indicus	—	1	1	1	5	8
Total	108	170	407	369	522	1576
Number of species	7	8	15	14	15	

of this locality yielded a total of 2,415 flies comprising 22 species, of which 21 belong to three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the genus *Drosophila* and one to the genus *Scaptomyza.* The occurrence, distributional pattern and the relative numbers of each of the species collected at 12 sites along with the respective altitudes of the sites are shown in table 5. Among the *Drosophila* species collected only four, namely *D. immigrans* (581 or 24.1%), *D. nasuta* (486 or 20.1%), *D. mysorensis* (383 or 15.9%) and *D. malerkotliana* (220 or 9.1%) were found to dominate the population of this locality forming nearly 70%. While three other species namely *D. rhopaloa* (176 or 7.3%), *D. giriensis* sp. nov. (157 or 6.5%) and *D. eugracilis* (110 or 4.6%) were observed in moderate numbers at some sites, and together contribute 18.4% to the total. The remaining 14 species of the genus *Drosophila* namely *D. takahashii, D. suzukii, D. ananassae, D. bipectinata, D. punjabiensis, D. jambulina, D. anomelani, D. gundensis* sp. nov., *D. neonasuta, D. brindavani, D. meijerei indicus, D. mundagensis,* species *'U'* and species *'N'* (unidentified members of the genus *Drosophila*) were found to occur in very low frequencies at some sites, forming only 12.4% of the total population. *Scaptomyza elmoi,* a member of the genus *Scaptomyza* was represented by only one individual in the collection. Considerable variation in the species composition and the number of individuals of different species was observed at different sites.

v) *Nagarhole* : *Drosophila* sample analysed from this locality revealed a total of 1,576 flies comprising 15 species representing three subgenera, *Sophophora, Drosophila* and *Scaptodrosophila* of the genus *Drosophila.* Collection data along with the respective altitudes of the sites are shown in table 6. Only four species namely *D. malerkotliana* (549 or 34.8%), *D. nasuta* (297 or 18.9%), *D. neonasuta* (203 or 12.9%) and *D. jambulina* (125 or 7.9%) form the major bulk with 74.5% of the total population. The remaining species namely *D. takahashii, D. eugracilis, D. bipectinata, D. punjabiensis, D. kikkawai, D. mysorensis, D. anomelani, D. nagaraholensis* sp. nov., *D. repleta, D. mundagensis* and *D. meijerei indicus* were found in comparatively low frequencies and comprise only about 25.5% of the total population. Considerable variation in the species composition and the number of individuals was noticed among the sites scanned in this locality.

3. *The Nilgiri Hills*

Kotagiri: *Drosophila* survey of this locality yielded a total of 1,505 flies comprising 11 species representing two genera, *Drosophila* and *Phorticella.* The occurrence and the relative frequencies of the species collected along with the respective altitudes of the sites are shown in table 7. The collection record reveals considerable uniformity in the species composition and the number of individuals among the five sites. Only three species, namely *D. immigrans* (598 or 39.7%), *D. malerkotliana* (395 or 26.2%) and *D. nasuta* (198 or 13.2%) were found to dominate with 79.1%. The other two species, *D. kikkawai* (93 or 6.1%) and *D. mysorensis* (82 or 5.5%) were found in all the sites. The remaining five species, *D. takahashii, D. elegans. D. anan-*

TABLE 7

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN KOTAGIRI (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	1400	1660	1725	1830	1960	
Genus: *Drosophila*						
Subgenus: *Sophophora*						
D. takahashii	—	13	28	6	9	56
D. elegans	12	1	7	—	—	20
D. ananassae	9	—	—	7	3	19
D. malerkotliana	104	78	64	53	96	395
D. mysorensis	13	9	18	29	13	82
D. kikkawai	18	25	11	31	8	93
D. seguyi	5	—	—	11	7	23
Subgenus: *Drosophila*						
D. nasuta	32	23	56	39	48	198
D. immigrans	85	93	121	146	153	598
D. nigra	3	—	—	8	5	16
Genus: *Phorticella*						
Phorticella flavipennis	—	2	—	—	3	5
Total	281	244	305	330	345	1505
Number of species	9	8	7	9	10	

assae, *D. seguyi* and *D. nigra* were found in moderate numbers at some sites and absent from others. Only five individuals of *P. flavipennis* were observed in two, of the five sites scanned.

4. *The Anamalai, Palni and Cardamom Hills*

Anamalai Hills' range: A total of 1,461 flies examined from this locality was found to comprise 12 species representing two genera, *Drosophila* and *Leucophenga*. The distributional pattern and the numbers of each species against the collection sites along with the respective altitudes are shown in table 8. Of the 12 species, only three namely *D. immigrans* (605 or 41.5%), *D. malerkotliana* (435 or 29.8%) and *D. nasuta* (156 or 10.7%) were found to dominate the collection with 81.9% While the remaining eight species of the genus *Drosophila* namely *D. takahashii*, *D. suzukii*, *D. eugracilis*, *D. kikkawai*, *D. rufa*, *D. rhopaloa*, *D. repleta* and *D. busckii* were found in low frequencies and represent only 18% of the total population. Only two individuals of *L. interrupta* were observed in one site, representing the genus *Leucophenga*.

The Drosophilid survey of the tropical rain forests of Western Ghats in the aforementioned localities yielded a total of 13,855 flies comprising 40 species representing four genera namely *Drosophila*, *Scaptomyza*, *Phorticella* and *Leucophenga*. Majority of the species collected belong to the genus *Drosophila*, while only three species belong to the latter three genera. Further, the members belonging

TABLE 8

DISTRIBUTION OF DIFFERENT SPECIES OF DROSOPHILIDAE IN ANAMALAI HILLS' RANGE (WESTERN GHATS)

Collection Site	I	II	III	IV	V	Total
Altitude (in metres)	800	1360	1640	2100	2400	
Genus: *Drosophila*						
Subgenus: *Sophophora*						
D. takahashii	—	9	15	18	7	49
D. suzukii	4	—	—	—	—	4
D. eugracilis	18	—	—	23	22	63
D. malerkotliana	65	48	93	101	128	435
D. kikkawai	13	19	11	7	—	50
D. rufa	—	13	9	21	8	51
D. rhopaloa	8	10	16	4	—	38
Subgenus: *Drosophila*						
D. nasuta	23	23	18	41	51	156
D. immigrans	88	131	125	78	183	605
D. repleta	—	1	2	3	—	6
Subgenus: *Dorsilopha*						
D. busckii	—	—	—	—	2	2
Genus: *Leucophenga*						
Leucophenga interrupta	—	—	2	—	—	2
Total	219	254	291	296	401	1461
Number of species	7	8	9	9	7	

TABLE 9

RELATIVE ABUNDANCE OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
D. takahashii	88	27	—	59	63	57	56	49	399
*D. giriensis**	—	—	—	—	157	—	—	—	157
*D. jagri**	—	—	—	46	—	—	—	—	46
D. suzukii	—	—	—	—	1	—	—	4	5
D. rajasekari	112	—	—	—	—	—	—	—	112
*D. sahyadrii**	—	9	—	—	—	—	—	—	9
*D. elegans***	—	—	—	—	—	—	20	—	20
D. eugracilis	—	62	80	70	110	54	—	63	439
D. ananassae	—	—	—	—	8	—	19	—	27
D. pseudoananassae	—	—	28	—	—	—	—	—	28
D. malerkotliana	777	678	339	289	220	549	395	435	3682
D. bipectinata	177	88	82	72	48	67	—	—	534
D. punjabiensis	698	—	—	—	25	65	—	—	788
D. jambulina	342	—	—	31	18	125	—	—	516
D. anomelani	—	109	140	220	46	41	—	—	556
D. mysorensis	—	40	—	200	383	39	82	—	744
D. kikkawai	—	—	—	—	—	40	93	50	183
D. montium	—	—	56	—	—	—	—	—	56
D. rufa	—	—	—	—	—	—	—	51	51
D. seguyi	—	—	—	—	—	—	23	—	23
*D. rhopaloa***	—	—	43	—	176	—	—	38	257
*D. gundensis**	—	—	—	26	8	—	—	—	34

TABLE 9 (Contd.)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagar-hole	Kotagiri	Anamalai Hills' range	Total
Species									
*D. agumbensis**	—	57	33	—	—	—	—	—	90
*D. nagarholensis**	—	—	—	—	—	16	—	—	16
Species '*U*'***	—	—	—	—	1	—	—	—	1
Species '*N*'***	—	—	—	—	11	—	—	—	11
D. nasuta	301	433	278	184	486	297	198	156	2333
D. neonasuta	62	28	68	102	12	203	—	—	475
D. immigrans	—	—	—	232	581	—	598	605	2016
D. brindavani	27	—	—	—	6	—	—	—	33
D. repleta	—	—	—	—	—	8	—	6	14
D. nigra	—	—	—	6	—	—	16	—	22
*D. grandis***	—	—	2	—	—	—	—	—	2
D. meijerei indicus	—	—	—	—	1	8	—	—	9
D. mundagenesis	—	—	21	—	53	7	—	—	81
D. krishnamurthyi	66	—	—	—	—	—	—	—	66
D. busckii	10	—	—	—	—	—	—	2	12
*Scaptomyza elmoi***	—	—	—	—	1	—	—	—	1
Leucophenga interrupta	—	—	—	—	—	—	—	2	2
*Phorticella flavipennis***	—	—	—	—	—	—	5	—	5
Total	2660	1531	1170	1537	2415	1576	1505	1461	13855
Number of species	11	10	12	13	22	15	11	12	

* New species; ** New reports; *** Unidentified species.

TABLE 9

RELATIVE ABUNDANCE OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
D. takahashii	88	27	—	59	63	57	56	49	399
*D. giriensis**	—	—	—	—	157	—	—	—	157
*D. jagri**	—	—	—	46	—	—	—	—	46
D. suzukii	—	—	—	—	1	—	—	4	5
D. rajasekari	112	—	—	—	—	—	—	—	112
*D. sahyadrii**	—	9	—	—	—	—	—	—	9
*D. elegans***	—	—	—	—	—	—	20	—	20
D. eugracilis	—	62	80	70	110	54	—	63	439
D. ananassae	—	—	—	—	8	—	19	—	27
D. pseudoananassae	—	—	28	—	—	—	—	—	28
D. malerkotliana	777	678	339	289	220	549	395	435	3682
D. bipectinata	177	88	82	72	48	67	—	—	534
D. punjabiensis	698	—	—	—	25	65	—	—	788
D. jambulina	342	—	—	31	18	125	—	—	516
D. anomelani	—	109	140	220	46	41	—	—	556
D. mysorensis	—	40	—	200	383	39	82	—	744
D. kikkawai	—	—	—	—	—	40	93	50	183
D. montium	—	—	56	—	—	—	—	—	56
D. rufa	—	—	—	—	—	—	—	51	51
D. seguyi	—	—	—	—	—	—	23	—	23
*D. rhopaloa***	—	—	43	—	176	—	—	38	257
*D. gundensis**	—	—	—	26	8	—	—	—	34

TABLE 9 (Contd.)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range	Total
Species									
*D. agumbensis**	—	57	33	—	—	—	—	—	90
*D. nagarholensis**	—	—	—	—	—	16	—	—	16
Species *'U'****	—	—	—	—	1	—	—	—	1
Species *'N'****	—	—	—	—	11	—	—	—	11
D. nasuta	301	433	278	184	486	297	198	156	2333
D. neonasuta	62	28	68	102	12	203	—	—	475
D. immigrans	—	—	—	232	581	—	598	605	2016
D. brindavani	27	—	—	—	6	—	—	—	33
D. repleta	—	—	—	—	—	8	—	6	14
D. nigra	—	—	—	6	—	—	16	—	22
*D. grandis***	—	—	2	—	—	—	—	—	2
D. meijerei indicus	—	—	—	—	1	8	—	—	9
D. mundagenesis	—	—	21	—	53	7	—	—	81
D. krishnamurthyi	66	—	—	—	—	—	—	—	66
D. busckii	10	—	—	—	—	—	—	2	12
*Scaptomyza elmoi***	—	—	—	—	1	—	—	—	1
Leucophenga interrupta	—	—	—	—	—	—	—	2	2
*Phorticella flavipennis***	—	—	—	—	—	—	5	—	5
Total	2660	1531	1170	1537	2415	1576	1505	1461	13855
Number of species	11	10	12	13	22	15	11	12	

* New species; ** New reports; *** Unidentified species.

to genus *Drosophila* are represented by four subgenera namely *Sophophora, Drosophila, Scaptodrosophila* and *Dorsilopha,* of which the former two comprise the major bulk with 98.6% of the total population. The species composition and the relative abundance of different species in the localities under investigation are summarised in table 9. The localities were found to differ a great deal in the composition of the *Drosophila* species, inspite of the similarities of the habitats in the environmental factors such as temperature, humidity, rainfall, vegetation, availability of food, etc. Similarly, the variations in the number of individuals of different species was a common feature among the sites of any one locality (tables 1-8). Perusal of table 9 reveals that only 11 species namely *D. malerkotliana, D. nasuta, D. takahashii, D. eugracilis, D. bipectinata, D. neonasuta, D. anomelani, D. mysorensis, D. immigrans, D. jambulina* and *D. punjabiensis* were found to occur in considerable numbers. Of these only two species *D. malerkotliana* and *D. nasuta* were observed in large numbers in almost all the localities. In addition, *D. immigrans* was found to be another abundant species in four of the eight localities. These three species contribute nearly 58.2% to the total *Drosophila* sample analysed. The remaining eight species contribute 32.2% to the total population. Thus the above mentioned 11 species together comprise 90.4% of the total flies collected in the area. while the remaining species of the *Drosophila* sample were represented by only a few individuals.

The occurrence and the distributional pattern of Drosophilid species collected in the present study is shown in table 10. The pattern of distribution of different species was found to vary a great deal. The abundant species mentioned above, except *D. punjabiensis,* were found to be present in more than four localities, while the others were observed in less than four localities. Only two species *D. malerkotliana* and *D. nasuta* were noticed in all the localities. But *D. takahashii* was observed in seven, *D. eugracilis, D. bipectinata* and *D. neonasuta* in six, *D. anomelani* and *D. mysorensis* in five, *D. jambulina* and *D. immigrans* in four localities. Thus these species which were observed in more than four localities have been considered as more or less widely distributed. The remaining species which were observed in less than four localities have been treated as sparsely distributed.

Among the Drosophilids collected in the present study, six species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagaraholensis* and *D. gundensis* are new. In addition, three species *D. elegans, D. rhopaloa* and *D. grandis* of the genus *Drosophila,* one species *S. elmoi,* a member of the genus *Scaptomyza,* and another *P. flavipennis,* a member of the genus *Phorticella* have been collected for the first time from India. The relative numbers and distributional pattern of these species are shown in table 9 and 10.

Discussion

The study of evolution in any group of animals or plants implies a knowledge of the number and distribution of the species involved and the population structure and habits of the species in relation to their environment (Heed 1957). Genus *Drosophila* with its cosmopolitan nature and complexities in species composition provides an excellent material to understand the ecodistributional pattern of various species. Systematic study concerning the variations in species composition and the distributional pattern of the mem-

TABLE 10

DISTRIBUTION OF DROSOPHILIDS IN EIGHT LOCALITIES OF WESTERN GHATS

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range
Species								
Genus: *Drosophila*								
D. takahashii	+	+	–	+	+	+	+	+
*D. giriensis**	–	–	–	–	+	–	–	–
*D. jagri**	–	–	–	+	–	–	–	–
D. suzuki	–	–	–	–	+	–	–	+
D. rajasekari	+	–	–	–	–	–	–	–
*D. sahyadrii**	–	+	–	–	–	–	–	–
*D. elegans***	–	–	–	–	–	–	+	–
D. eugracilis	–	+	+	+	+	+	–	+
D. ananassae	–	–	–	–	+	–	+	–
D. pseudoananassae	–	–	+	–	–	–	–	–
D. malerkotliana	+	+	+	+	+	+	+	+
D. bipectinata	+	+	+	+	+	+	–	–
D. punjabiensis	+	–	–	–	+	+	–	–
D. jambulina	+	–	–	+	+	+	–	–
D. anomelani	–	+	+	+	+	+	–	–
D. mysorensis	–	+	–	+	+	+	+	–
D. kikkawai	–	–	–	–	–	+	+	+
D. montium	–	–	+	–	–	–	–	–
D. rufa	–	–	–	–	–	–	–	+
D. seguyi	–	–	–	–	–	–	+	–
*D. rhopaloa***	–	–	+	–	+	–	–	+
*D. gundensis**	–	–	–	+	+	–	–	–
*D. agumbensis**	–	+	+	–	–	–	–	–
D. nagarholensis	–	–	–	–	–	+	–	–
Species *'U'****	–	–	–	–	+	–	–	–
Species *'N'****	–	–	–	–	+	–	–	–
D. nasuta	+	+	+	+	+	+	+	+
D. neonasuta	+	+	+	+	+	+	–	–
D. immigrans	–	–	–	+	+	–	+	+
D. brindavani	+	–	–	–	+	–	–	–
D. repleta	–	–	–	–	–	+	–	+
D. nigra	–	–	–	+	–	–	+	–
*D. grandis***	–	–	+	–	–	–	–	–
D. meijerei indicus	–	–	–	–	+	+	–	–
D. mundagenesis	–	–	+	–	+	+	–	–
D. krishnamurthyi	+	–	–	–	–	–	–	–
D. busckii	+	–	–	–	–	–	–	+

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TABLE 10 (*Contd.*)

Localities	Khandala Ghats	Sahyadri Hills' range	Agumbe	Jagra Valley	Bababudangiri & Kemmangundi Hills' range	Nagarhole	Kotagiri	Anamalai Hills' range
Genus: *Scaptomyza*								
*S. elmoi***	–	–	–	–	+	–	–	–
Genus: *Leucophenga*								
L. interrupta	–	–	–	–	–	–	–	+
Genus: *Phorticella*								
*P. flavipennis***	–	–	–	–	–	–	+	–

+ Species present; – Species absent; * New species; ** New reports;
*** Unidentified members of the genus *Drosophila*.

bers of this genus in different geographical regions of the earth will enable one to understand the principles underlying adaptive radiation and certain mechanisms involved in speciation. Reference to literature reveals that *Drosophila* species are not evenly distributed in nature. The occurrence and the distributional pattern can be correlated not only with the type of vegetation and climatic conditions of the area under consideration but also with the colonizing abilities of the species concerned.

The eight localities of Western Ghats from which *Drosophila* samples were analysed exhibit similarity in the habitats with more or less uniform macro-environmental factors such as temperature, humidity, rainfall, vegetation, availability of food, etc. Inspite of this, the localities differ from one another with regard to the species composition and the number of individuals of different species. Further significant variation in the number of individuals of different species was observed amongst the sites chosen under study. These observed differences in the faunal constellation of *Drosophila* species among the sites of any one locality and between the different localities may be accounted for by the differences in the micro-environmental factors.

Reddy and Krishnamurthy (1974), Siddaveere Gowda *et al.* (1977) have pointed out that even though several species could be collected in the orchards, gardens, plantations and some forested areas of Peninsular India, only four species namely *D. malerkotliana, D. nasuta, D. rajasekari* and *D. brindavani* were found to be dominant and more or less widely distributed. But the present study on the *Drosophila* fauna of tropical rain forests of Western Ghats revealed a different picture in the composition of the species. For instance, only two species — *D. malerkotliana* and *D. nasuta* were found to be distributed throughout the range of Western Ghats dominating other species in the collections. While the other two species, *D. rajasekari* and *D. brindavani* were shown to be present in only one or two localities indicating their lack of competence to colonize in the tropical rain forests. Therefore, based on the distribution and the dominance of the species in the natural habitats of the Peninsula only two species, *D. malerkotliana* and *D. nasuta* can be adjudged as generalist species. Their wide-

spread occurrence and dominance over others in the area under investigation can be correlated with their ecological versatility to exploit diverse habitats. Interestingly, *D. immigrans* which was not reported from the semi-wild and domestic localities of Peninsular India was observed in large numbers in four of the eight localities of Western Ghats indicating its preference to the moist and humid climatic conditions. Further, nine species namely *D. takahashii, D. bipectinata, D. pseudoananassae, D. mysorensis, D. jambulina, D. montium, D. neonasuta, D. nigra* and *D. meijerei indicus* which were occasionally reported in the plains of Peninsula were found to occur more or less frequently in the tropical rain forests indicating the availability of favourable breeding sites for their colonization. The domestic species such as *D. melanogaster, D. ananassae* and *D. repleta* which occur mainly in and around human habitations obviously as expected were absent in the tropical rain forests except for a few individuals of *D. ananassae* and *D. repleta* at some sites indicating their inability to colonize in the tropical rain forests where other species dominate. The most noteworthy feature of the Drosophilid fauna of the area under investigation is the occurrence of many species such as *D. suzukii, D. eugracilis, D. anomelani, D. punjabiensis, D. kikkawai, D. rufa. D. seguyi, D. mundagensis, D. krishnamurthyi* and *L. interrupta* which were not reported from the plains of Peninsula In additions the collection data revealed the occurrence of six new species namely *D. giriensis* (Prakash and Reddy, 1977), *D. jagri* (Prakash and Reddy, 1979), *D. sahyadrii* (Prakash and Reddy, 1979), *D. agumbensis* (Prakash and Reddy, 1978), *D. nagarholensis* (Prakash and Reddy, 1980) and *D. gundensis* (Prakash and Reddy, 1977). Similarly five species, *D. elegans, D. rhopaloa, D. grandis, S. elmoi* and *P. flavipennis* found in the collections are new records from the sub-continent. In view of this, the Drosophilid fauna of Western Ghats is of special interest and value as it offers a rich abode for a variety of species. Moreover, it is clear from the data that the species diversity in the tropical rain forests of Western Ghats is exceedingly more complex than that of other habitats of the Peninsula, thus indicating the dependance of *Drosophila* species upon the types of vegetation. Therefore, we are of the opinion that the complex natural habitats with diverse plant species provide large number of breeding sites for the colonization by diverse species of *Drosophila.* The tropical rain forests of Western Ghats are considered to have played a unique role in the adaptive radiation and paved the way for extensive speciation in the members of the genus *Drosophila.* This does not, of course, necessarily mean that no new or rare species will be found in the habitats other than moist deciduous and evergreen forests. But the probability of such discovery must be regarded as low. Further, intensive collections of *Drosophila* species from this area are needed to decide, if indeed any species is restricted to one or few sites, and if so, what special ecological niche is being exploited.

A great majority of the species are endemic to particular geographical areas of the earth. Thus it is apparent that each of the six continental regions (Darlington 1957) appears to have their own characteristic constellation of indigenous species. According to Stone *et al.* 1960, the endemism may amount to 95% of the known species of the genus *Drosophila.* Carson (1965), recognized three distinct groups based on the pattern of distribution of various members of the genus *Drosophila.* They are, 1. species having restricted distribution (endemism of Patterson and Stone 1952),

2. virtually cosmopolitan species and 3. species having a tendency to spread widely but not cosmopolitan. Only eight species, *D. melanogaster, D. simulans, D. ananassae, D. hydei, D. repleta, D. busckii, D. immigrans* and *D. funebris* are listed in the second category. In addition to cosmopolitan species, a number of species may be recognized which have some tendency to spread geographically but still have not become world-wide. Nine of the species listed in this category are *D. latifascisformis, D. pseudoobscura, D. kikkawai, D. nebulosa, D. willistoni, D. virilis, D. buzzatii, D. mercatorum* and *D. nasuta.* However, this category should not be taken as a precise one as it serves only to focus attention on certain species which have characteristics that place them in a roughly intermediate position between the endemic species on one hand and the cosmopolitan species on the other.

Of the 37 *Drosophila* species recorded in the present study 13 species of which, six are new, namely, *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagarholensis* and *D. gundensis* were described by us; and seven others namely *D. anomelani, D. mysorensis, D. neonasuta, D. brindavani, D. meijerei indicus, D. mundagenesis* and *D. krishnamurthyi* have been considered as endemic to India, since they are not reported elsewhere.

With regard to the second category of Carson 1965, only four of the eight cosmopolitan species namely, *D. ananassae, D. immigrans, D. repleta* and *D. busckii* were observed in the present study. However, *D. melanogaster*, another cosmopolitan species, which can be trapped from almost all the human habitated localities of Peninsular India was found to be absent in the collections. The absence of *D. melanogaster* and three other cosmopolitan species, *D. simulans, D. hydei* and *D. funebris* from the collections is a noteworthy feature and corroborates with the earlier studies on the *Drosophila* species inhabiting the forested areas of the sub-continent (Gupta 1974, Reddy and Krishnamurthy 1974). Therefore, the present investigation indicates that the cosmopolitan species which have been recorded mainly from human habitations have hardly been found to be invaded into an otherwise unsuitable niche. It is presumed that the resources are fully utilised by other ecologically versatile species thus preventing the colonization of the cosmopolitan species in these habitats. Several authors (cf. Watts 1971) have recorded that closed forest communities rarely receive invading plants, since competition for niches may be severe. Because of the dependance of *Drosophila* on plants as a resource, the lack of success of cosmopolites is to be expected in the rain forests (Bock and Parsons 1977). Thus, the present finding is in support of the statement of Dobzhansky (1965) who viewed that none of the cosmopolitan species are truely so, but have reached the quasi-cosmopolitan status with man's aid.

Of the nine species listed in the third category only two species *D. kikkawai* and *D. nasuta* were noticed in the present collections. However, other species such as *D. takahashii, D. suzukii, D. rajasekari, D. elegans, D. eugracilis, D. pseudoananassae, D. malerkotliana, D. bipectinata, D. punjabiensis, D. jambulina, D. montium, D. rufa, D. seguyi, D. rhopaloa, D. nigra* and *D. grandis* found in the collections may also be assigned to the intermediate position as judged by their occurrence in other parts of the world.

Brncic (1970), has categorised the *Drosophila* species into two groups namely widespread and endemic species. According to him the widespread or endemic character of

a species in the absence of geographical barriers is a function of the abundance and distribution of the ecological resources that the species may utilize. The existence of endemism may be an expression of the ecological restriction. For instance, the endemic species that have been referred to in the present investigation appear to be closely related to the tropical moist deciduous and evergreen forests of Western Ghats except for *D. mysorensis, D. neonasuta* and *D. brindavani* which were reported to be present in other habitats of the Peninsula. Similarly, the wide distribution of a species does not always need to be related to the ecological versatility. Probably this is the case for some of the domestic cosmopolitan species which are adjusted to some human made habitats. Majority of the species collected from the Western Ghats have also been reported from other parts of the world indicating their wide spread nature. The reason for the widespread occurrence of these species could be correlated with the ecological versatility enabling them to live and reproduce in many different environments.

The most interesting feature of the collection data is that, although many species could be collected at any particular locality, members of the *melanogaster* and *immigrans* species groups belonging to two subgenera *Sophophora* and *Drosophila* comprise all or practically all of the catch indicating the sympatric association and ecological dominance of the members belonging to these two species groups. However, certain other species such as *D. repleta, D. nigra, D. grandis, D. meijerei indicus, D. mundagenesis, D. krishnamurthyi* and *D. busckii* belonging to other subgenera were also found occasionally in the collection. Further, it is clear from the present study that the members of the *melanogaster* species group in particular were found to be more versatile as evidanced by the variety of species. Thus the ecological dominance of the members of the *melanogaster* and *immigrans* species groups observed is in conformity with the earlier reports on the South Indian *Drosophila* fauna (Reddy and Krishnamurthy 1974, 1977 and Siddaveere Gowda *et al.* 1977) and also with the suggestion of (Bock and Wheeler 1972), who regarded the Indian subcontinent as the general area for the origin of *melanogaster* species group, and South-East Asia in general, for the origin and wide speciation for both *melanogaster* and *immigrans* species groups. Incidentally the finding of six new species and two new records of species belonging to *melanogaster* species group from this area further supports the suggestion of Bock and Wheeler (1972). Based on our collection data, it is obvious that the suggested dominance of the members of the two species groups belonging to two different subgenera of the genus *Drosophila* in a substantial area of the world is in itself a unique phenomenon. With more intensive collections of *Drosophila* in Western Ghats, it is possible to understand many problems concerning the origin and evolution as well as the distribution and ecological relationships of the members of these two subgenera.

Subramanyam and Nayar (1974) have pointed out that the Western Ghats behave like an oceanic island in the development of endemic species of plants as it is protected by sea on Western side, Vindhya and Satpura on northern side and semiarid Deccan plateau on eastern side. Similarly the present investigation has revealed the occurrence of 13 endemic species, of which six species namely *D. giriensis, D. jagri, D. sahyadrii, D. agumbensis, D. nagarholensis* and *D. gundensis* are new. In addition, five Drosophilid species namely *D. elegans, D. rhopaloa, D. grandis, S. elmoi*

and *P. flavipennis* are new reports from the sub-continent. Further several species which are not reported from the plains of Peninsula were observed in the present study. In view of these findings, the species diversities in Western Ghats is found to be exceedingly more complex than that of other habitats of Peninsular India. Therefore, we are of the opinion that the Western Ghats with its luxuriant flora and geographic position not only acts as a nursery ground for speciation of *Drosophila* but also as a centre for the development of endemic species.

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A SKETCH ON THE SEDGE AND GRASS FLORA OF JALPAIGURI DISTRICT, WEST BENGAL[1]

J. K. Sikdar[2]

The paper lists 42 species belonging to 10 genera of sedges and 126 species belonging to 66 genera of grasses occurring in Jalpaiguri district. The precise localities with reference to forest ranges and forest divisions in this district together with collector's name and numbers have been given against each species.

Introduction

The district of Jalpaiguri, is situated between 26°16′ & 27°0′ north latitude, and between 88°15′ & 89°53′ east longitude. It is bounded by Assam state in the east, part of Darjeeling district and Bangladesh in the west, part of Darjeeling district and Bhutan in the north and part of Bangladesh and Coochbehar district in the south. The total area of the district is 6,234.13 sq. km. The headquarters is at Jalpaiguri on the right bank of the Tista river, situated roughly 32 km. from the nearest forest reserve. The district is mainly a plain land with the exception of Buxaduar hills and a part of Titi area. Sinchula is the highest peak of Buxaduar hills (± 1912 m).

The district is made up of alluvium with deposits of coarse gravel near the hills on the north, sandy clay and sand along the course of rivers. The beds of Buxa hills consist of variegated slates, quartzites and dolomites. The rainfall is heavy in this district and more on the north-eastern part (towards Buxaduar hills). The average annual rainfall of the district is 3925.1 mm (154.33″). In the Jalpaiguri town the mean maximum temperature in April is 31.7°C.

The first account of sedges and grasses of Bengal was given by Prain (1903). Among later works, which deal with only sedges or only grasses or both sedges and grasses of the present day West Bengal, the following may be mentioned — Banerjee (1968), Chakravarty (1957), Chaudhuri (1959a, 1960a, 1965), Dutta & Maiti (1963), Guha (1971), Guha Bakshi & Sen (1977), Majumdar (1956), Matthew (1966, 1981), and Paul & Bhattacharya (1959). The works of Hara (1966, 1971) and Ohashi (1975) on eastern Himalayas also cover Darjeeling hills of this state. Recently a list of grasses of Bihar, Orissa and West Bengal was given by Jain *et al.* (1975). But the complete exploration of sedges and grasses of many districts of West Bengal has, not so far been done. The only account of sedges and grasses of Buxa forest division and Jalpaiguri forest division of this district was given by Chaudhuri (1959b, 1960b) but such records were not represented by a single specimen in the Central National Herbarium, Howrah (CAL) and other Indian herbaria. Moreover he has not mentioned any precise localities of the taxa. The other two forest divisions of Jalpaiguri district, i.e. Baikunthapur and Coochbehar still remains unpublished. Mukerjee (1965) though published a sketch on the vegetation of Jalpaiguri district, but it includes only a few taxa of sedges and grasses.

I have (Sikdar 1981) in connection with my studies on the "Vegetation and Flora of Jalpaiguri district, West Bengal" from 1974

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[2] Central National Herbarium, Botanical Survey of India, Howrah-711 103.

to 1979 made a thorough collection of sedges and grasses from twenty different forest ranges including cultivated fields, barren lands etc. distributed into four different forest divisions in the district. Besides my own collections, a few collections of sedges and grasses by others from this district available in CAL were examined and incorporated in this communication. Only a few taxa have been added here based on literature (Chaudhuri 1959b, 1960b) and (Mukerjee 1965) to prepare a complete account as far as possible. All the collections have been deposited in the Central National Herbarium, Howrah (CAL).

Altogether 42 species of sedges (Cyperaceae) belonging to 10 genera and 126 species of grasses (Poaceae) belonging to 66 genera have been enumerated in this paper. In systematic enumeration, name of each species is followed by precise locality/localities with symbol in bracket indicating the name of forest division and forest range which is again followed by collector's name and number. In case of the species which have been included on the basis of literature, author's name is used followed by page number. The genera and species are arranged in alphabetical order within the family. The nomenclature of the taxa has been given upto date as far as possible. Symbols as given in the brackets represent the respective forest ranges in each forest division and such symbols are used to indicate the localities of various species, collected during this study.

'A' = Baikunthapur Forest Division:
(A_1) = 7th Mile range;
(A_2) = Sarugara range;
(A_3) = Ambari range;
(A_4) = Belacoba range and
(A_5) = Apalchand range.

'B' = Jalpaiguri Forest Division:
(B_1) = Upper Tondu range;
(B_2) = Lower Tondu range;
(B_3) = Diana range and
(B_4) = Moraghat range.

'C' = Coochbehar Forest Division:
(C_1) = Madarihat range;
(C_2) = Nilpara range;
(C_3) = Jaldapara range and
(C_4) = Chilapata range.

'D' = Buxa Forest Division:
(D_1) = Nimati range;
(D_2) = Damanpur range;
(D_3) = Rajabhatkhawa range;
(D_4) = Jainti range;
(D_5) = Buxaduar range;
(D_6) = Raidak range and
(D_7) = Bholka range.

The list of various plant collectors who had collected sedges and grasses from Jalpaiguri district, as represented by only a few sheets in CAL, except my own collection with large number of gatherings and now being incorporated in this work is given below indicating the year/years of their collection in bracket after each name:

Agarwal, S. C. (1956); Biswas, K. P. (1944, 1948, 1949); Burkill, I. H. (1906-1909); Chaudhuri (1959-1960); Das, C. R. (1959); Guha, M. P. (1955-1956); Indo-Russ. Expe. to E. Him. & N. Bengal (1961); Molla, H. A. & Pal, D. C. (1978); Molla, H. A. & Roy, B. (1979); Mudram, G. H. (1956); Mukerjee, S. K. (1962); Nanda, P. C. (1956); Narayanswami, V. (1949); Ribu & Rhomoo (1911) and Sikdar, J. K. (1975-1977).

The collections of sedges and grasses by the above mentioned collectors except Chaudhuri (1959b, 1960b) and Mukerjee (1965) are still unpublished. Hence this is an attempt to prepare a complete list of sedges and grasses as far as possible occurring in Jalpaiguri district mainly based on my own collections from the district.

SYSTEMATIC ENUMERATION

CYPERACEAE

Bulbostylis barbata (Rottb.) Clarke
Indong (B_1), *J. K. Sikdar* 338.

Carex indica Linn.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.

C. japonica Thunb.
Gajalduba (A_5), *S. K. Mukerjee* 5580.

C. stramentitia Boott. ex Bockeler
Buxa road (D_3), *K. P. Biswas* 1645 (5 sheets); Near Buxaduars (D_5), *K. P. Biswas* 2037 (5 sheets).

C. wallichiana Presc. ex Hook f.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.

Cyperus brevifolius (Rottbl.) Hassk.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7013.

C. compactus Retz.
Chel, Kathambari (A_5), *J. K. Sikdar* 52; South Bholka (D_7), *J. K. Sikdar* 4202.

C. compressus Linn.
Murti riverbed (B_1), *J. K. Sikdar* 365.

C. cuspidatus Kunth
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.

C. cyperoides (Link.) O. Kuntze
Mendabari, Chilapata (C_4), *J. K. Sikdar* 638; Chel, Kathambari (A_5), *S. K. Mukerjee* 5573.

C. diffusus Vahl
Laltong (A_1), *J. K. Sikdar* 199; Santrabari (D_5), 350 m, *J. K. Sikdar* 7024; Jainti (D_4), *V. Narayanswami* 3010; Buxa road (D_3), *K. P. Biswas* 1651.

C. digitatus Roxb.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.

C. distans Linn. f.
Chapramari (B_1), *J. K. Sikdar* 304.

C. exaltatus Retz.
Baradabri (C_4), *Indo-Russian Exped. to E. Himal. & N. Bengal* 370.

C. flavidus Retz.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91; Buxa forest division (D), Chaudhuri, *l.c.* 472.

C. halpan Linn.
Mendabari (C_4), *J. K. Sikdar* 627; Rajabhatkhawa (D_3), *K. P. Biswas* 1637.

C. iria Linn.
Way to Buxaduar hills (D_5), 550 m, *J. K. Sikdar* 7025; Buxa-Santrabari (D_5), 300 m, *V. Narayanswami* 2908.

C. lucidus R. Br.
Jalpaiguri forest division (B), Chaudhuri *l.c.* 91.

C. nutans Vahl
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91; Buxa forest division (D), Chaudhuri *l.c.* 472.

C. pilosus Vahl
Mendabari (C_4), *J. K. Sikdar* 637.

C. platystylis R. Br.
Jalpaiguri plains, Terai (B), *Ribu & Rhomoo* 4969.

C. silletensis Nees ex Wight
Bania (C_4), *J. K. Sikdar* 574; Khairbari forest (C_1), *C. R. Das* 105.

C. sulcinux Clarke
Jalpaiguri forest division (B), Chaudhuri *l.c.* 91.

C. tenuispica Steud.
Damanpur (D_2), *J. K. Sikdar* 912.

Fimbristylis aestivalis (Retz.) Vahl
Phuljhora (A_5), *J. K. Sikdar* 69; Rajabhatkhawa (D_3), *V. Narayanswami* 2485; Alipurduar (D), *C. R. Das* 79.

F. dichotoma (Linn.) Vahl
Chapramari (B_1), *J. K. Sikdar* 267; Rajabhatkhawa (D_3), *V. Narayanswami* 2485; Buxa camp (D_3), *V. Narayanswami* 2960.

F. falcata (Vahl) Kunth
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.
F. miliacea (Linn.) Vahl
Damanpur (D_2), *J. K. Sikdar* 909.
F. schoenoides (Retz.) Vahl
Chilapata (C_4), *J. K. Sikdar* 576; Mendabari (C_4), *J. K. Sikdar* 606.
Kyllinga nemoralis (Forster) Dandy ex Hutch.
Mendabari (C_4), *J. K. Sikdar* 623.
K. tenuifolia Steud.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91; Buxa forest division (D), Chaudhuri, *l.c.* 422.
Mariscus cyperinus (Retz.) Vahl
Chapramari (B_1), *J. K. Sikdar* 242.
Pycreus globosus (Allioni) Reichb.
Jalpaiguri forest division (D), Chaudhuri, *l.c.* 91.
P. pumilus (Linn.) Nees
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.
P. stramineus C. B. Clarke
Near Buxaduars (D_5), *K. P. Biswas* 2037.
Rikliella squarrosa (Linn.) J. Roynal
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.
Scirpus articulatus Linn.
Chel, Kathambari (A_5), *J. K. Sikdar* 7167.
S. comosus Wall. ex Roxb.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.
S. juncoides Roxb.
Chilapata (C_4), *J. K. Sikdar* 578.
S. mucronatus Linn.
Apalchand, Tista bank (A_5), *J. K. Sikdar* 173.
Scleria terrestris (Linn.) Fass.
Mech basti, Apalchand (A_5), *Molla & Pal* 20375.
S. tessellata Willd.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 91.

Poaceae (= Gramineae)

Acroceras zizanioides (H. B. K.) Dandy
Garam (D_2), *J. K. Sikdar* 899.
Alloteropsis cimicina (Linn.) Stapf
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 90.
Apluda mutica Linn.
Jaldapara game sanctuary (C_3), *J. K. Sikdar* 719.
Apocopis paleacea (Trin.) Hochr.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 90.
Arundinella bengalensis (Spreng.) Druce
Jaldapara game sanctuary (C_3), *J. K. Sikdar* 716; Jalpaiguri (B), *I. H. Burkill* 29011 & 27391.
A. decempedalis (O. Kuntze) Janowski
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89; Jalpaiguri district, Mukerjee, *l.c.* 134.
Arundo donax Linn.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
Axonopus compressus (Sw.) P. Beauv.
Buxa-santrabari (D_5), 200 m, *V. Narayanswami* 2940.
Bambusa arundinacea (Retz.) Willd.
Titi-3 (C_1), 225 m, *J. K. Sikdar* 4560.
B. balcooa Roxb.
Jalpaiguri district, Mukerjee, *l.c.* 136.
B. pallida Munro.
Jalpaiguri district, Mukerjee, *l.c.* 136.
B. tulda Roxb.
Jalpaiguri district, Mukerjee, *l.c.* 136.
B. vulgaris Schrad.
Jalpaiguri district, Mukerjee, *l.c.* 136.
Brachiaria distachya (Linn.) Stapf
Buxa-Santrabari (D_5), 200 m, *V. Narayanswami* 2937.
B. milliformis (Presl) A. Chase
Gorumara II (B_2), *P. C. Nanda* 264.
B. ramosa (Linn.) Stapf
Rajabhatkhawa (D_3), *J. K. Sikdar* 7187.

B. reptans (Linn.) Gard. et Hubbard
Bania (C_4), *J. K. Sikdar* 555; Bhutanghat (D_6), *V. Narayanswami* 3094.

B. setigera (Retz.) C. E. Hubb.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.

Capillipedium assimile (Steud.) A. Camus
Bhutanghat (D_6), *V. Narayanswami* 3068.

Centotheca lappacea (Linn.) Desv.
Poro (D_1), *J. K. Sikdar* 789 & 803; South Bholka (D_7), *J. K. Sikdar* 4180.

Cephalostachyum capitatum Munro.
Jalpaiguri district, Mukerjee, *l.c.* 136.

Chloris dolichostachya Lagasca
Bhutanghat (D_6), *V. Narayanswami* 3018.

Chrysopogon aciculatus (Retz.) Trin.
Chapramari (B_1), *J. K. Sikdar* 245; Rajabhatkhawa (D_3), *J. K. Sikdar* 7020.

Coelorhachis khasiana (Hack.) Stapf ex Bor.
Bichabhanga II, Lataguri (B_2), *M. P. Guha* 260.

C. striata (Nees ex Steud.) A. Camus
Buxa forest division (D), Chaudhuri, *l.c.* 472.

Coix lacryma-jobi Linn.
Jaldapara game sanctuary (C_3), *J. K. Sikdar* 725.

Cymbopogon flexuosus (Nees ex Steud.) Wats.
Lataguri (B_2), *M. P. Guha* 255.

C. jwarancusa (Jones) Schult.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 88.

C. nardus Linn.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 88.

C. schoenanthus (Linn.) Spreng.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 90.

Cynodon dactylon (Linn.) Pers.
Apalchand (A_5), *J. K. Sikdar* 7164; Buxaduar (D_5), 750 m *J. K. Sikdar* 7175.

Cyrtococcum accrescens (Trin.) Stapf
Bhutanghat (D_6), *V. Narayanswami* 3104.

C. oxyphyllum (Steud.) Stapf
Road to Murichom, 37th mile (D_5), 1400 m, *V. Narayanswami* 2825.

C. patens (Linn.) A. Camus
Rajabhatkhawa (D_3), *J. K. Sikdar* 7138; Buxa-Santrabari (D5), 350 m, *V. Narayanswami* 2910.

Dactyloctenium aegypticum (Linn.) P. Beauv.
Chel, Kathambari (A_5), *J. K. Sikdar* 7177.

Dendrocalamus hamiltonii Nees et Arn.
Jalpaiguri district, Mukerjee, *l.c.* 136.

Desmostachya bipinnata (Linn.) Stapf
Central Moraghat (B_4), *J. K. Sikdar* 7189.

Dichanthium annulatum (Forssk.) Stapf
Buxa prison (D_5), 800 m, *V. Narayanswami* 2980.

Digitaria longifolia (Retz.) Pers.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7073.

D. preslii (Kunth) Henr.
Ambari (A_3), *J. K. Sikdar* 7022.

D. sanguinalis (Linn.) Scop.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.

D. setigera Roth apud Roem. et Schult.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 86.

Echinochloa colonum (Linn.) Link.
Balapara (D_7), *J. K. Sikdar* 4181; Bhutanghat (D_6), *V. Narayanswami* 3111.

E. crusgalli (Linn.) P. Beauv.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.

E. stagenina (Retz.) P. Beauv.
Simulbari, Jalpaiguri, 300 m, *K. P. Biswas*, s.n.

Eleusine coracana (Linn.) Gaertn.
Garam (D_2), *J. K. Sikdar* 878 & 879.

E. indica (Linn.) Gaertn.
Chapramari (B_1), *J. K. Sikdar* 246; Buxa,

Santrabari (D_5), 200 m, *V. Narayanswami* 2916; Bhutanghat (D_6), *V. Narayanswami* 3105 & 3019.

Elytrophorus spicatus (Willd.) A. Camus
Central Moroghat (B), *J. K. Sikdar* 7155.

Eragrostis cilianensis (All.) Vignolo-lutali
Chel, Kathambari (A_5), *J. K. Sikdar* 56.

E. coarctata Stapf
Rajabhatkhawa (D_3), *J. K. Sikdar* 7048.

E. diarrhena (Schult.) Steud.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7071.

E. gangetica (Roxb.) Steud.
Patgram, Jalpaiguri, *I. H. Burkill* 30706.

E. japonica (Thunb.) Trin.
Moynabari (D_6), 200 m, *J. K. Sikdar* 4143; Balapara (D_7), *J. K. Sikdar* 4222.

E. nigra Nees ex Steud.
Buxa-Bhutan Road, 36th mile (D_5), 1200 m, *V. Narayanswami* 2562.

E. pilosa (Linn.) P. Beauv.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7072.

E. tenella (Linn.) P. Beauv. ex Roem. et Schult.
Rajabhatkhawa (D_3), *J. K. Sikdar* 7070.

E. uniloides (Retz.) Nees ex Steud.
Apalchand (A_5), *J. K. Sikdar* 164; Chilapata (C_4), *J. K. Sikdar* 575; Poro (D_1), *J. K. Sikdar* 768; Garam (D_2), *J. K. Sikdar* 858; South Bholka (D_7), *J. K. Sikdar* 4233.

Erianthus longisetosus Anderss.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.

Eriochloa procera (Retz.) C. E. Hubb.
Bhutanghat (D_6), *V. Narayanswami* 3087.

Eulalia trispicata (Schult.) Henr.
Rajabhatkhawa (D_3), *K. P. Biswas* 1560.

Hemarthria compressa (Linn. f.) R. Br.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7000.

Hygroryza aristata (Retz.) Nees ex Wight
Khutimari (B_4), *J. K. Sikdar* 7191.

Imperata cylindrica (Linn.) P. Beauv.
Chapramari (B_1), *J. K. Sikdar* 243; Rajabhatkhawa (D_3), *C. R. Das* 4.

Isachne globosa (Thunb.) O. Ktze.
Gorumara game sanctuary (D_2), *J. K. Sikdar* 7211.

I. miliacea Roth
Jalpaiguri forest division (B), *J. K. Sikdar* 89.

Ischaemum rugosum Salisb.
Chel, Kathambari (A_5), *J. K. Sikdar* 7167.

Leersia hexandra Sw.
Jalpaiguri forest division (B), Chaudhuri *l.c.* 89.

Microstegium ciliatum (Trin.) A. Camus
Poro (D_1), *J. K. Sikdar* 795; Bhutanghat (D6), *J. K. Sikdar* 4115; Balapara (D_7), *J. K. Sikdar* 4171; Gorumara game sanctuary (D_2), *S. C. Agrawal* 270.

M. vagans (Nees ex Steud.)
Garam (D_2), *J. K. Sikdar* 863.

Narenga fallax (Balansa) Bor
Bhutanghat (D_6), *V. Narayanswami* 3112.

N. porphyrocoma (Hance) Bor
Rajabhatkhawa (D_3), *J. K. Sikdar* 7069; Laltong (A_2), *K. P. Biswas* 6489.

Neyraudia arundinacea (Linn.) Hern.
Jaldapara game sanctuary (C_3), *J. K. Sikdar* 737; Buxa road (D_3), *K. P. Biswas* 1679.

N. reynaudiana (Kunth) Keng
Bhutanghat (D_6), 300 m, *J. K. Sikdar* 4120.

Oplismenus burmannii (Retz.) P. Beauv.
Bhutanghat (D_6), 300 m, *J. K. Sikdar* 4116.

O. compositus (Linn.) P. Beauv.
Poro (D_1), *J. K. Sikdar* 794; Garam (D_2), *J. K. Sikdar* 859; Way to Buxaduars (D_5), 800 m, *K. P. Biswas* 1796; Bhutanghat (D_6), *V. Narayanswami* 3095.

Oryza minuta J. S. Presl ex C. B. Presl
Mechbasti, Apalchand (A_5), *Molla & Pal* 20380.

O. sativa Linn.
Kathambari (A_5), *J. K. Sikdar* 4586.
Ottochloa nodosa (Kunth) Dandy
Bhutanghat (D_6), *V. Narayanswami* 3108.
Panicum auritum Presl ex Nees
Jaldapara east (C_4), *Molla & Roy* 20853.
P. humidorum Buch.-Ham. ex Hook. f.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
P. notatum Retz.
Poro (D_1), *J. K. Sikdar* 798; Rajabhatkhawa (D_3), *K. P. Biswas* 1562; Barodabri (C_4), *Indo-Russian Exped. to E. Himal. & N. Bengal* 360.
P. paludosum Roxb.
North Rajabhatkhawa (D_3), *J. K. Sikdar* 7074.
P. psilopodium Trin.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
P. repens Linn.
Bhutanghat (D_6), *V. Narayanswami* 3087.
P. sarmentosum Roxb.
Churabhija, Apalchand (A_5), *J. K. Sikdar* 113.
P. trypheron Schult.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
Paspalidium flavidum (Retz.) A. Camus
Buxa-Santrabari (D_5), 200 m, *V. Narayanswami* 2941; Buxa camp (D_5), 800 m, V. *Narayanswami* 2941.
P. punctatum (Burm.) A. Camus
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
Paspalum conjugatum Berg.
South Diana (B_3), *J. K. Sikdar* 374; Buxa-Bhutan Road, 36th mile (D_5), 1200 m, *V. Naravanswami* 2564; Rajabhatkhawa Depot Road (D_3), *V. Narayanswami* 2416 & 2417.
P. orbiculare Forst.
Chapramari (B_1), *J. K. Sikdar* 241; Jaldapara game sanctuary (C_3), *J. K. Sikdar* 717.
P. scrobiculatum Linn.
Buxa-Bhutan Road, 36th mile (D_5), 1200 m, *V. Narayanswami* 2554; Bhutanghat (D_6), *V. Narayanswami* 3075; Buxa camp (D_5), 800 m, *V. Narayanswami* 2955.
Perotis indica (Linn.) O. Ktze.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 90.
Phragmites karka (Retz.) Trin. ex Steud.
South Bholka (D_7), *J. K. Sikdar* 4224; Apalchand (A_5), *J. K. Sikdar* 168.
Poa annua Linn.
Sinchu, near Bhutan border (D_5), 1800 m, *J. K. Sikdar* 6918.
Pogonatherum crinitum (Thunb.) Kunth
Gosaihat (B_4), *J. K. Sikdar* 455; Rajabhatkhawa (D_5), *C. R. Das* 103.
P. paniceum (Lamk.) Hack.
Saraswatipur (A_2), *J. K. Sikdar* 211; Titi (C_1), 200 m, *J. K. Sikdar* 4535.
Polytoca digitata (Linn. f.) Druce
Bhutanghat (D_6), *V. Narayanswami* 3109.
Pseudechinolaena polystachya (H. B. K.) Stapf
Tista valley, Jalpaiguri, *I. H. Burkill* 34072.
Pseudostachyum polymorphum Munro.
Jalpaiguri district, Mukerjee, *l.c.* 136.
Rottboellia exaltata Linn. f.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
Saccharum arundinaceum Retz.
Rajabhatkhawa (D_3), *J. K. Sikdar* 7068.
S. bengalense Retz.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.
S. officinarum Linn.
Apalchand (A_5), *J. K. Sikdar* 7166.
S. procerum Roxb.
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 88; Jalpaiguri district, Mukerjee, *l.c.* 134.
S. ravennae (Linn.) Murray
Jalpaiguri forest division (B), Chaudhuri,

l.c. 88; Jalpaiguri district, Mukerjee, *l.c.* 134.

S. spontaneum Linn.
Jaldapara game sanctuary (C_3), *J. K. Sikdar* 736.

Sacciolepis indica (Linn.) A. Chase
Rajabhatkhawa (D_3), *V. Narayanswami* 2365; Tista sand banks, Jalpaiguri, *G. H. Mudram* 250.

S. interrupta (Willd.) Stapf
Apalchand (A_5), *S. K. Mukerjee* 5618; Dukshin Kar Dighi, Lataguri (B_2), *S. C. Agrawal* 257.

S. myosuroides (R. Br.) A. Camus
Chapramari (B_1), *J. K. Sikdar* 281.

Schizachyrium brevifolium (Sw.) Nees ex Buse
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 89.

Sclerostachya fusca (Roxb.) A. Camus
Gorumara game sanctuary (B_2), *V. Narayanswami* 3132.

Setaria glauca (Linn.) P. Beauv.
Chapramari (B_1), *J. K. Sikdar* 240; Jaldapara game sanctuary (C_1), *J. K. Sikdar* 738; Buxa-Santrabari (D_5), 250 m, *V. Narayanswami* 2936.

S. italica (Linn.) P. Beauv.
Simulguri (A_3), *J. K. Sikdar* 510.

S. pallide-fusca (Schum.) Stapf et Hubb.
Madarihat (C_1), *J. K. Sikdar* 698.

S. palmifolia (Koen.) Stapf
Bania (C_4), *J. K. Sikdar* 4336.

S. plicata (Lamk.) T. Cooke
Laltong (A_1), *K. P. Biswas* 6528.

Sorghum halepense (Linn.) Pers.
Poro (D_1), *J. K. Sikdar* 776.

Sporobolus diander (Retz.) P. Beauv.
Chapramari (B_1), *J. K. Sikdar* 244; South Rajabhatkhawa (D_3), *J. K. Sikdar* 4271; Buxa-Santrabari (D_5), 200 m, *V. Narayanswami* 2917.

S. fertilis (Steud.) W. D. Calayton
Rajabhatkhawa (D_3), *J. K. Sikdar* 7047; 21 miles from Rajabhatkhawa (D_3), *V. Narayanswami* 2349.

Themeda arundinacea (Roxb.) Ridley
Buxa road (D_3), *K. P. Biswas* 1620.

T. caudata (Nees) A. Camus
Hanskhali, Apalchand (A_5), *J. K. Sikdar* 102; Laltong (A_1), *J. K. Sikdar* 200; South Bholka (D_7), *J. K. Sikdar* 4198.

T. villosa (Poir.) A. Camus
Jalpaiguri forest division (B), Chaudhuri, *l.c.* 88.

Thysanolaena maxima (Roxb.) O. Kuntze
Buxaduar (D_5), 800 m, *J. K. Sikdar* 4657; Way to Sinchu (D_5), 1600 m, *J. K. Sikdar* 6917; Buxa-Bhutan road, 36th mile (D_5), *V. Narayanswami* 2519.

Vetiveria zizanioides (Linn.) Nash
Garam (D_2), *J. K. Sikdar* 903; Balapara (D_7), *J. K. Sikdar* 4151.

Triticum aestivum Linn.
Chel (A_5), *J. K. Sikdar* 80; Chengmari (A_5), *J. K. Sikdar* 117.

Zea mays Linn.
Chengmari (A_5), *J. K. Sikdar* 129; Rajabhatkhawa (D_3), *J. K. Sikdar* 4602; Rajabhatkhawa Depot road (D_3), *V. Narayanswami* 2457.

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RHESUS MONKEY DISTRIBUTION IN THE LOWER HIMALAYAS AND SECONDARY FOREST SUCCESSION[1]

KAZUO WADA[2]

(*With a text-figure*)

Rhesus monkeys are found throughout Southern Asia in various habitat conditions, and utilize actively artificial habitats such as terrace fields and streets. They prefer *Pinus*-dominated forest and secondary mixed broad-leaved forests which are affected by human activity.

It seems that the *Pinus*-dominated forest expanded by the cutting of previous primary forests, and was maintained by continuous human activity. At present, deciduous broad-leaved forests are distributed patchily, whereas before expansion of *Pinus*-dominated forests, broad-leaved forests were common.

Rhesus monkeys would predate humans in inhabiting the deciduous and evergreen broad leaved forest with conifers, so after expansion of human activity, the monkeys would have acquired terrace fields and streets as newly appeared habitat, and their distribution area and population levels would not have been remarkably reduced.

INTRODUCTION

Recently, ecological studies of Rhesus monkeys are increasing in the Indian Subcontinent focussing on distribution, troop structure and habitat utilization etc. (Mandel 1964, Neville 1968, Lindburg 1971, Mukherjee & Mukherjee 1972, Lindburg 1976, Makwana 1978, Teas *et al.* 1980, Koyama & Shekar 1981 and Wada 1983). We can also find studies of typology of vegetation and forest succession (Puri 1960, Kanai 1966, Numata 1967, Stainton 1972, and Ohsawa, Shakiya & Numata 1973).

I found Rhesus monkeys utilizing terrace fields and forests (Wada 1983). If Rhesus monkeys are forest inhabitants, it is a most interesting problem to determine how Rhesus monkeys acquired the newly appeared field as a habitat.

Based on Wada (1983), I try to presume the process acquiring terrace fields as a habitat of Rhesus monkeys.

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HABITAT CONDITION OF RHESUS MONKEYS

The Rhesus monkey is distributed widely through South Asia (from Afghanistan in the west to the south-central part of China), in various habitats ranging from dry forest to humid forest, and from tropical to temperate or sometimes alpine zones vertically. The distribution map of Rhesus monkeys was made referring to Tan *et al.* (1965), Puget (1971), Fooden (1971), Zhang *et al.* (1981), Koyama & Shekar (1981), and Wada (1983) (Fig. 1). It is possible to define that this species inhabits a variety of habitats.

Rhesus monkeys utilize not only various types of forest but also cultivated fields and streets. The monkeys are common along streets and temples (Mukherjee 1969), and Wada (1983) pointed out that forest-occupying troops include fields in each home range,

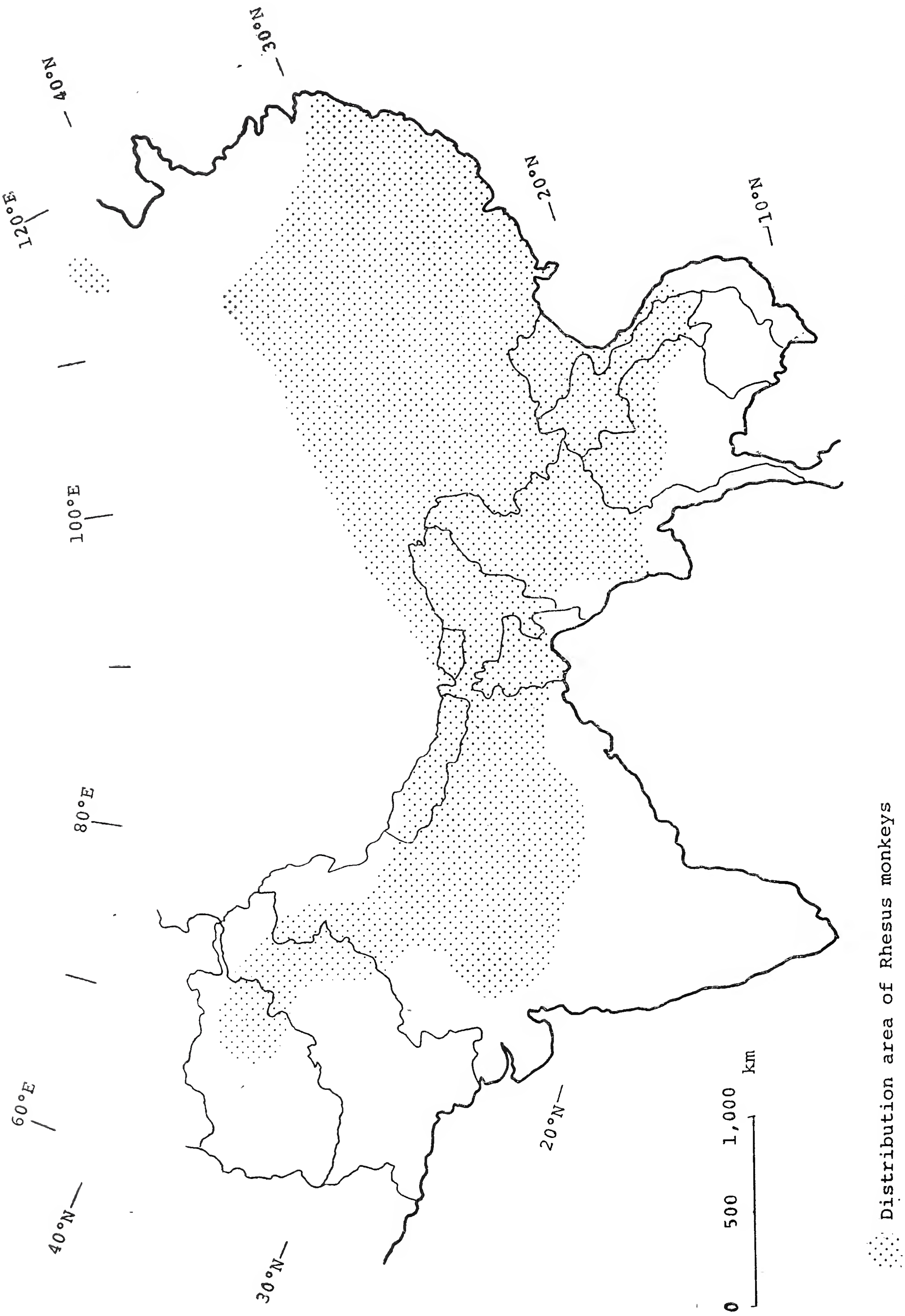
30°N
40°N
20°N
10°N
120°E
100°E
80°E
60°E
20°N
40°N
30°N
0 500 1,000 km
Distribution area of Rhesus monkeys

Fig. 1.

and they are distributed continuously in both habitats, avoiding *Cedrus deodara*-dominated, and *Quercus* dominated huge forests.

Rhesus monkeys prefer fruits, seeds, leaves of trees and grasses, especially seeds of *Pinus wallichiana* and *P. roxburghii,* leaves of *Berberis aristata,* leaves and stems of *Trifolium repens* and fruits of *Vitis himalayana* in the temperate forest, and corn, potatoes, peas and young leaves of wheat in fields. Lindburg (1976) listed 92 species of their foods in the subtropical forest, Wada (1983) listed 35 species in forests and 14 species in fields and streets in the temperate forest. But, they met with a scarcity of foods in *Cedrus deodara* and *Quercus*-dominated forests, so they moved to mainly *Pinus*-dominated forests and secondary mixed broad-leaved forests where they can easily obtain food.

Generally, when human activity deteriorates the habitats' condition for animals by the exploitation of forests and utilization of domestic animals, their distributional area will shrink, and their activity also will be weakened. But the Rhesus monkeys' attitude is different from that of other animals, it seems that the monkeys adapted to the newly appeared habitat, and did not reduce their distribution range.

Crops are important food for Rhesus monkeys in the lower Himalayas. This may be related to changes in the secondary forest succession resulting from human activities.

Discussion

Origin of Pinus-*dominated Forests in the lower Himalayas*

Pinus-dominated forests containing *Cedrus deodara, Picea* and *Quercus* are common not only in Himachal Pradesh but also in the lower Himalayas in India and Nepal. In Himachal Pradesh, *Pinus*-dominated forests form a zone between 500 m above sea level (a.s.l.) and 2,500 m a.s.l.

The forest types in Nepal were classified by Stainton (1972) as follows: (1) tropical and subtropical, (2) temperate and alpine broad-leaved, (3) temperate and alpine coniferous, and (4) minor temperate and alpine associations. As the survey areas ranged from warm temperate to subtropical zones, little natural forest remained due to human impact. It is possible to estimate natural forest characteristics from the remaining secondary forest.

The existence of the deciduous broad-leaved forest (cold temperate forest) can be presumed on the basis of the small deciduous broad-leaved forest remaining around Hatoo Peak (3,200 m a.s.l.), 64 km North-East of Simla and along the Kulu valley, 100 km North-West of Simla. Directly under Hatoo Peak, there is a deciduous broad-leaved forest including dominant *Acer* and *Betula.* In the areas between 2,500 m a.s.l. and the upper limit of the forest zone along Kulu valley, coniferous forest is distributed with *Acer* and *Salix* in the lower region, changing to *Betula*-dominated forest in the upper region. It seems reasonable to conclude that the deciduous broad-leaved forest would have been distributed in nearly the same forest zone as *Quercus semecarpifolia* forests.

According to Puri (1960), in the western and central Himalayas there is a middle oak zone (1,500-2,400 m a.s.l.) where *Quercus dilatata*-dominated forests occur with *Q. incana, Acer, Aesculus* and *Litsaea* etc. My observations confirm that Kulu valley contains coniferous mixed forests with *Aesculus indica* and *Acer.*

There are locally mixed forests of *Quercus* and deciduous broad-leaved trees in the *Quercus semecarpifolia*-dominated (2,400-3,800 m a.s.l.) and *Aesculus-Juglans-Acer* forests (1,900-

2,800 m a.s.l.) of Humla, Jumla and the west midlands, and in the lower and upper temperate mixed broad-leaved forests (1,500-3,200 m a.s.l.) (Stainton 1972). Ohsawa, Shakya and Numata (1973) noted the existence of *Acer*-dominated forests in the cold temperate zone in eastern Nepal.

Kanai (1966) described 5 forest types in a vertical distribution in the Singalila range, East Nepal, where deciduous broad-leaved forests are distributed patchily in evergreen oak forests (1,700-2,800 m a.s.l.) and in Rhododendron conifer forests (2,500-4,000 m a.s.l.).

Deciduous broad-leaved forests, which dominate in the northern part of the Japanese Islands, are distributed in the northern and central parts of China, and have become rare in the eastern parts of the Himalayan ranges. There, this forest is mixed with oak or coniferous forests without forming an original vegetation zone, but sometimes constitutes a locally dominant zone.

The Oak forest occupies the temperate zone as climax in the Kumaon Himalayas and Central Himalayas (Puri 1960, Stainton 1972). In these areas, *Pinus wallichiana*-dominated forest appeared as a secondary forest. After desolation of terrace fields and overgrazing of undergrowth or burning of the forest, *P. wallichiana* invaded these areas to form a dominant forest. Numata (1967) suggested that at 900-2,300 m a.s.l. in eastern Nepal, *Pinus roxburghii* becomes dominant as secondary forest, while at 2,300-2,800 m a.s.l. *P. wallichiana* is dominant. The undergrowth is poor due to chemicals released from pine leaves, and strong erosion in the monsoon season.

These authors do not mention the changing process from oak forest to pine forest in detail. One factor may be the over utilization of undergrowth by domestic animals, inhibiting young tree growth of the dominant species, and another may be accelerated surface layer erosion. Thus, natural forest regeneration is first inhibited by overgrazing of domestic animals, and erosion leads to loss of the fertile ground surface layer. In such areas, pine trees can grow more easily than other kinds of trees, so secondary succession to pine-dominated forests would be favoured.

We can refer to the secondary pine forest formation process in Japan in discussing the conversion process to pine forest in the Himalayas. From the standpoint of secondary forest, *Pinus roxburghii* and *P. wallichiana* occupy an ecological niche similar to that of *P. densiflora* in Japan.

The ecological character of *Pinus densiflora* was described by Kato (1972) as follows : *P. densiflora* is widely distributed from the lower plains to the alpine zone in Honshu, Shi koku and Kyushu. This pine can flourish even in poor soil conditions where other kinds of trees cannot invade. *Pinus densiflora*-dominated forests are regenerated with the pine trees growing quickly as sun trees fixed to almost naked substratum after cutting or burning. The pine forests gradually change to broad-leaved forests with the undergrowth of the pine forest as the lower layer.

In the Indian subcontinent, oak forests, *Cedrus-Picea-Abies* coniferous forests and mixed forests are exploited as grazing areas for domestic animals until the timberline abuts against the glaciers; the undergrowth is completely grazed, and the animals' paths form a downtrodden mesh. Oak-tree leaves, including branchlets, around villages are utilized as food by domestic animals in winter.

Thus, it can be concluded that oak forests or mixed forests are destroyed by long-term nomadism of domestic animals and by the forest-exploiting activities of humans and burning, then at an altitude of 1,500-3,000 m a.s.l.,

pine forests penetrate them as secondary forests in regions where natural regeneration is inhibited and soil erosion has occurred in warm temperate and cold temperate zones. If pine forest once formed is neglected, it changes to other types of forest, but it is normally maintained by incessant activity.

Such secondary pine forests are distributed all over the Himalayan and Mahabharat ranges. Stainton (1972) indicated that secondary forests of *Pinus wallichiana* are well distributed in central and west-central Nepal, and Puri (1960) mentioned that similar forests are widely distributed in the temperate zone of the Punjab and Garhwal Himalayas. At the western parts of the Himalayas from Sikkim the human population is denser, and the secondary forest area of pine trees should be more extensive.

Rhesus monkey distribution in the alpine zone

Rhesus monkeys should be distributed up to the upper boundary of crop cultivation. Japanese trekkers who have visited Nepal have said that Rhesus monkeys are found in all regions of Nepal. The upper boundary of crop cultivation is in the areas between 2,400 m and 3,000 m a.s.l. in Nepal (Kanai 1966, and my unpublished data), and this upper boundary nearly coincided with the upper limit of Rhesus monkey distribution in Nepal (Richie *et al.* 1978, Teas *et al.* 1980, and my unpublished data).

In Shanshi, China, near the northern limit of Rhesus monkey distribution, *Betula*- and *Quercus*-dominated deciduous broad-leaved forests at 1,000-2,000 m a.s.l. provide a habitat for monkeys, since areas below 1,000 m are occupied by cultivated fields (Tan *et al.* 1965). In South-west China, Rhesus monkeys reach at 3,400 m a.s.l. in altitude (Zhang *et al.* 1981). Evergreen broad-leaved forests in the southern and eastern parts and deciduous broad-leaved forests in the central part of China provide habitats for Rhesus monkeys. As Rhesus monkeys also take many kinds of crops for food in these areas (Shaw ed., 1962), it is thought that Rhesus monkeys inhabit the natural forest (Tan *et al.* 1965), areas of mixed natural forest and cultivated fields, as found in the highlands of India and Nepal.

As in China, Rhesus monkeys inhabit deciduous and evergreen broad-leaved forests. There are oak forests including deciduous board-leaved forests and coniferous forests in the Mahabharat as well as the Himalayan ranges, and if forest destruction due to human activity was less in such areas, Rhesus monkeys could inhabit mixed oak-dominated forests with deciduous broad-leaved trees and conifers.

As regards the vertical distribution of Rhesus monkeys, the upper limit may rise to the level of the upper boundary of crops, but there have been other opinions: within deciduous broad-leaved forests (1,000-2,000 m a.s.l.) in Shanshi, China, Rhesus monkeys occupied alpine zones before humans expanded their activity into these regions.

Rhesus monkey adaptation to environmental changes

Rhesus monkeys have been faced with the problem of adaptation to increasing areas of terrace fields and waste lands newly formed by humans. It may be suggested that more kinds of trees were present in evergreen forests, deciduous broad-leaved forests, or in mixed forests than in coniferous forests, so that fruits, nuts and leaves in the former were more abundant than in the latter during all seasons. It is very difficult to estimate the availability of fruits or leaves to monkeys in such forests, but

TABLE 1

VERTICAL DISTRIBUTION OF VEGETATION ZONES IN THE NEPAL HIMALAYAS (*after* Stainton, 1972 *with some modifications by the author*)

Kind of vegetation zone	No. of tree species in each forest storey (1)	(2)	(3)	(4)
Sal forest				
Bhabar and Terai Sal fr.	15	7	4	
Hill Sal fr.	8	5	4	2
Tropical Deciduous Riverain fr.	17	9	5	10
Tropical Evergreen fr.				
East Nepal	32	15	24	11
West Nepal	13	10	5	6
Subtropical Evergreen fr.	23	11	3	7
Subtropical Deciduous Hill fr.	23	5	3	
Schima-Castanopsis fr.	9	10	8	1
Subtropical Semi-evergreen Hill fr.	21	23	17	11
Pinus roxburghii fr.				
West Midlands	1	5		
Quercus incana-Q. lanuginosa fr.				
West Midlands	2	7	13	7
Quercus dilatata fr.				
West Midlands	14	18	15	8
Quercus semecarpifolia fr.				
West Midlands	1	9	8	4
Castanopsis tribuloides-C. hystrix fr.	3	12	9	8
Quercus lamellosa fr.				
Central and East Nepal	3	21	8	10
Lithocarpus pachyphylla fr.	3	20	5	2
Aesculus-Juglans-Acer fr.				
West Midlands	8	8	7	2
Humla-Jumla area	17	13	11	
Lower Temperate mixed Broad-leaved fr.				
West Midlands	13	13	4	7
Central and East Midlands	21	21	19	12
Upper Temperate mixed Broad-leaved fr.	28	21	11	
Betula utilis fr.				
Central Midlands	2	10	1	
Humla-Jumla area	1	18	3	1
Abies spectabilis fr.				
Central and East Midlands	2	5	13	1
Jumla area	1	11	24	3
West Midlands	1	2	5	
Tsuga dumosa fr.				
West Midlands	4	9	17	6
Pinus excelsa fr.				
Humla-Jumla area	5	21	33	

TABLE 1 (Contd.)

	(1)	(2)	(3)	(4)
Picea smithiana fr.				
Rara lake	2	9	9	
Humla area	3	11	21	4
Abies pindrow fr.				
Humla area	3	13	13	3
Cedrus deodara fr.	3	9	1	
Cupressus torulosa fr.	1	15	2	
Populus ciliata woods	4	15	3	
Juniperus wallichiana fr.				
West Midlands	4	18	2	1

(1) Trees which form the top canopy
(2) Trees forming a second storey
(3) Smaller trees and shrubs
(4) Climbers and epiphytes

it is possible to compare the kinds of trees in each forest. Stainton (1972) divided the forest structure into 4 layers which were described as follows: (1) trees constituting the top canopy, (2) trees forming the second layer, (3) lower trees and scrubs, and (4) vines and epiphytes. In areas at 1,500-2,500 m a.s.l. surveyed this time, there are lower and upper temperate mixed broad-leaved forests, *Tsuga dumosa* forests, *Pinus wallichiana* forests, *Picea smithiana* forests, *Abies pindrow* forests and *Cedrus deodara* forests. Among these forests, the number of tree species in different coniferous forests is fewer than in broad-leaved forests (Table 1). However, Rhesus monkeys may take the bulk of their food from the bigger and more abundant seeds of *Pinus wallichiana*. There are no monkey troops with their entire home ranges in pine forests alone, and it may be very difficult to maintain troop movement in such a forest only because of the simplicity of monkey habitat condition.

The other change of habitat for Rhesus monkeys is the appearance of terrace fields. Grasslands would have existed before the human advance to the midland and alpine regions, but they did not greatly influence the habitat conditions of Rhesus monkeys, since the forest fringe would supply abundant food. The destruction of forests and forest undergrowth by domestic animal grazing and the disappearance of forests due to the expansion of terrace fields caused deterioration and disappearance of the original habitat of the monkeys. However, Rhesus monkeys were able to find food in terrace fields as a new habitat. Further, the quantity and quality of monkey food were high even under the original, relatively primitive agricultural conditions.

At present, the monkey troop distribution is continuous, and monkey troops are abundant throughout survey areas. Thus, the species is dominant even now. Human activity has affected their habitat, but food is still available, i.e., seeds of pine trees, some kinds of undergrowth and fruits of vines. Thus, their distribution area and population level would not have been remarkably reduced.

The ability of monkeys to accommodate newly appearing habitat conditions into their

modes of life may be closely related to the fact that they were originally, eating young leaves, buds, fruits, nuts, seeds and roots of plants. Langurs inhabiting the same forests as Rhesus monkeys rarely enter terrace fields.

Active acquisition of terrace fields as habitats by Rhesus monkeys was found during feeding within fields. When there are no watchmen, monkey troops feeding in fields are dispersed, even near the farmers' houses. If farmers or dogs pursue the monkeys, they escape to trees around the terrace fields, then wait there. Sometimes, highly ranked males face dogs without running away. The abovementioned behaviour was found in the case of Japanese monkeys. Such behaviour may be related to the acquisition of new habits or population dynamics in response to the impact of human activities.

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MATERIAL FOR THE FLORA OF MAHABALESHWAR-5

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[*Continued from Vol.* 79(3): 619]

Myrsinaceae

1. Fruits many seeded; calyx thick and enclosing the fruit .... *Maesa*
1. Fruits 1-seeded; calyx not thick, not enclosing the fruit .... *Embelia*

Embelia Burm. f.

1. Flowers tetramerous .... *E. basaal*
1. Flowers pentamerous 2
   2. Leaves oblong-lanceolate; lateral veins indistinct .... *E. ribes*
   2. Leaves broadly elliptic; lateral veins prominent .... *E. tsjeriam-cottam*

1. **Embelia basaal** (Roem. & Schultz.) DC., in Trans. Linn. Soc. (London) 17: 131, 1834; Dalz. & Gibs. 136; Mez, in Pfreich 9: 328, t. 54, 1902.

Ardisia basaal Roem. & Schultes, Syst. 4:517, 1819.
Samara rheedii Wight, Icon. t. 1591, 1852.
E. viridiflora Clarke, in Flora Brit. India, 3: 516, 1882 (non Scheff., 1867); Cooke, T. 2:86 (2: 145); Santapau, 399, 1962 & 302, 1963; Puri & Mahajan, 126.

Common rambling climbers with warted branches found at Dhobi's falls, Kate's point, Arthur seat, Lodwick point, Chinaman's Falls and near Madhu Kosh.

FLOWERS: June-November; FRUITS: December-April.

2. **Embelia ribes** Burm. f., Flora Ind. 62, t. 23, 1768; Graham, 104; Dalz. & Gibs. 137; FBI 3: 513; Cooke, T. 649 & 2: 84 (2: 143); Markham, 386; Birdwood, 17; Puri & Mahajan, 126.

E. glandulifera Wight, Icon. t. 1207, 1848; Dalz. & Gibs. 137.

It is a rare species in Fitzgerald Ghat. We have only collected it in sterile condition.

LOCAL NAMES: Waiwarang, Vavding.

3. **Embelia tsjeriam-cottam** (Roem. & Schult.) DC., in Trans. Linn. Soc. (London) 17: 131, 1834; Wight, Icon. t. 1209, 1848; Mez, in Pfreich 9: 319, t. 52A-J, 1902; Santapau, 399, 1962 & 301, 1963.

Ardisia tsjeriam-cottam Roem. & Schultes, Syst. 4: 518, 1819.
E. robusta Brandis, For. Fl. 2: 284, 1874 (non Roxb. 1832); FBI 3: 515; Cooke, T. 2: 85 (2: 44); Birdwood, 17.

A large rambling or scandent shrub. Very common along the edges of the forest.

FLOWERS: September-December; FRUITS: September-March.

LOCAL NAMES: Ambuti, Wauri.

Maesa Forsk.

1. **Maesa indica** (Roxb.) DC., Trans. Linn. Soc. (London) 17: 134, 1834; Dalz. & Gibs. 136; Lisboa, 216; FBI 3: 509; Cooke, T. 649 & 2: 82 (2: 141); Birdwood, 17; Markham, 386; Lee, 646; Puri & Mahajan, 126.

Baeobotrys indica Roxb., Fl. Indica, 2: 230, 1824.
M. perottetiana DC., Prodr. 8:8, 1844.
M. indica var. *perottetiana* (DC.) C. B. Clarke, in Fl. Brit. India 3:509, 1882.

Common and abundant shrub along the fringes of forests and along road-sides in ghat areas. It is especially common at Bombay point, Tiger path, Dhobi's falls, Chinaman's falls, Fitzgerald ghat, Falkland point and Lodwick point.

FLOWERS & FRUITS: August-March.

LOCAL NAME: Atki.

Sapotaceae

1. Sepals uniseriate; stamens 5-6 .... *Xantolis*
1. Sepals biseriate 2
   2. Petals 8 .... *Mimusops*
   2. Petals 6 .... *Manilkara*

Manilkara Adans.

1. **Manilkara zapota** (Linn.) van Royen, in Blumea, 7: 410, 1953.

Achras zapota Linn. Sp. Pl. 1190, 1753; FBI 3: 354; Cooke, T. 2: 96 (2: 156).

Cultivated occasionally in private gardens.

FLOWERS: Throughout the year.

LOCAL NAME: Chiku.

Mimusops Linn.

1. **Mimusops elengi** Linn., Sp. Pl. 349, 1753; FBI 3: 548 Cooke, T. 2: 95 (2: 155); Puri & Mahajan, 126.

A rare tree. Occasionally planted in gardens.

FLOWERS: June-October; FRUITS: September-March.

LOCAL NAME: Bakuli.

Xantolis Raf.

1. **Xantolis tomentosa** (Roxb.) Raf., Sylv. Tell. 36, 1838; van Royen, in Blumea 8: 226, 1957; Santapau, 142.

Sideroxylon tomentosum Roxb., Pl. Corom. 1:28, t. 28, 1795; Graham, 105; FBI 3: 538; Cooke, T. 2: 90 (2: 150).

Pouteria tomentosa Baehni, in Candollea 9: 368, 1942.

Common tree all over Mahabaleshwar. Some trees possess sharp, more than 3 cm. long spines, but very often trees are spineless.

FLOWERS: November-May; FRUITS: Throughout the year.

LOCAL NAMES: Kumbhal, Kate-kumbhal.

Ebenaceae

Diospyros nigrescens (Dalz.) Saldanha (*Maba nigrescens* Dalz.) has been reported by Markham and *Diospyros montana* Roxb. and *Diospyros assimilis* Bedd. have been reported by Birdwood, in his catalogue (p. 17), but there are no specimens in any of the herbaria consulted to support the presence of these species at Mahabaleshwar.

Symplocaceae

Symplocos Jaquin

1. Drupe ampuliform, ribbed .... *S. laurina*
1. Drupe ellipsoid .... *S. beddomei*

1. **Symplocos beddomei** C. B. Clarke, in Hook. f., Flora Brit. India 3: 582, 1882; Nairne, 174; Cooke, T. 648 & 2: 108 (2: 109); Lee, 646; Puri & Mahajan, 126.

S. racemosa Graham, cat. Bombay Pl. 104, 1839 (non Roxb., 1832); Lisboa, 217.

Hoppea racemosa Dalz. & Gibs. Bombay Fl. 140. 1861. Markham, 386.

Very common tree at Lodwick point, Tiger path, Lingmala, Chinaman's falls, Dhobi's falls, and Carnac point. Graham describes it as the most ornamental tree of Mahabaleshwar.

FLOWERS: December-January;

FRUITS: April-May.

LOCAL NAMES: Kauli, Lodhra, Lenda.

This species has been merged with *Symplocos racemosa* Roxb. by T. P. Ramamurthy, in Flora of Hassan District (p. 200, 1976). Clarke (l. c.) expressed his doubt about its being a variety of that species and gave a number of points which distinguish it from Roxburgh's plant, a major point being that the fruit is ovoid and wider near the base. Ramamurthy does not give any reason for merging the two species. His decision seems to have been based on opinion of Dr. H. P. Nooteboom (Leiden), rather than the type studies of the Indian species. Our materials show ovoid-oblong fruits and we prefer to keep it under *S. beddomei* Clarke, until the status of this name is proved to the contrary.

2. **Symplocos laurina** (Retz.) Wall. ex Graham, Cat. Bombay Pl. 1839; Puri & Mahajan, 126; Santapau, 143.

Myrtus laurina Retz., Obs. 4:26, 1786.

S. spicata Roxb. Fl. Ind. 2: 541, 1832; FBI 3: 573; Wight, Ill. t. 150; Cooke, T. 2: 108 (2: 169).

S. spicata var. *laurina* C. B. Clarke, in Flora Brit. India 3: 573, 1882.

Hoppea spicata Dalz. & Gibs. Bombay Fl. 140, 1861; Markham, 386.

S. cochinchinensis ssp. *laurina* (Retz.) Nooteboom, Apud Ramamurthy, in Fl. Hassan Dist. 198, 1976.

This species is recorded here on the authority of Puri & Mahajan's report from Mahabaleshwar. We have not seen it growing on the plateau.

In Flora of Hassan District, T. P. Ramamurthy treats this taxon as a subspecies of *S. cochinchinensis* (Lour.) Moore, the name of which is based on *Drupatris cochinchinensis* Lour. (1790). In fact *Myrtus laurina* Retz. (1786), the basyonym of this subspecies, has a priority over Loureiro's name.

Oleaceae

1. Climbing shrubs .... *Jasminum*
1. Erect shrubs or trees 2
    2. Inflorescence terminal .... *Ligustrum*
    2. Inflorescence axillary 3
        3. Petals all connate................. *Olea*
        3. Petals connate in pairs...... *Chionanthus*

Chionanthus Gaertn.

1. **Chionanthus malabarica** (Wall. ex G. Don) Bedd. For. Man. Bot. 154, 1872; Beddome, Fl. Sylvat. t. 239, 1872; Nair & Janardanan, Journ. Bombay nat. Hist. Soc. 78(2): 331, 1981.

Linociera malabarica Wall. ex G. Don, Gen. Syst. 4: 53, 1837; Graham, 109; Wight, Icon. t. 1246, 1848; FBI 3: 607; Cooke, T. 2: 117 (2: 178).

Rare tree at Mahabaleshwar.

FLOWERS: November-February.

LOCAL NAME: Heddi.

Jasminum Linn.

1. Leaves simple 2
    2. An erect or sub-erect shrub........ *J. sambac*
    2. Climbing shrubs 3
        3. Bracts linear, subulate..... *J. malabaricum*
        3. Bracts foliaceous .... *J. multiflorum*
1. Leaves compound .... *J. officinale*

1. **Jasminum malabaricum** Wight, Icon. t. 1250, 1848; FBI 3: 594; Cooke, T. 2: 111 (2: 172); Santapau, in Journ. Bombay nat. Hist. Soc. 46: 563 & 302, 1963; Puri & Mahajan, 126.

J. latifolium Graham, Cat. Bombay Pl. 110, 1839 (non Roxb., 1832); Dalz. & Gibs. 138; Lisboa, 216.

J. arborescens var. *latifolia* Talbot, Trees Bombay (ed. 2) 216, 1902; Cooke, T. 649; Birdwood, 17.

Common climber all over Mahabaleshwar.

FLOWERS & FRUITS: February-June.

LOCAL NAME: Kusar.

2. **Jasminum multiflorum** (Burm. f.) Anders. Bot. Rep. 8, t. 496, 1801; G. L. Shah, Fl. Gujarat, 411, 1978.

Nyctanthus multiflora Burm. f., Fl. Indica, 5, t. 3, f. 1, 1763.

J. pubescens Willd., Sp. Pl. 1: 37, 1797; FBI 3: 592; Cooke, T. 2: 112 (2: 173).

Ornamental shrub, cultivated for its flowers.

FLOWERS: Throughout the year.

LOCAL NAME: Mogra, Jui.

3. **Jasminum officinale** Linn. Sp. Pl. 7, 1753; FBI 3: 603; Cooke, T. 2: 114 (2: 175).

Cultivated shrub with white fragrant flowers.

FLOWERS: Throughout the year.

LOCAL NAMES: Chameli, Jati-Jaie.

5. **Jasminum sambac** Ait., Hort. Kew 1: 8, 1789; Graham, 110; Dalz. & Gibs. 137; Wight, Icon. t. 704; FBI 3: 591; Cooke, T. 2: 111 (2: 172).

Cultivated for its fragrant flowers.

FLOWERS: Throughout the year.

LOCAL NAME: But-mogri.

Ligustrum Linn.

1. **Ligustrum perottettii** A. DC., in DC.

Prodr. 8: 294, 1844. var. **obovatum** (C. B. Clarke) Gamble, Fl. Madras 2: 798 (561), 1923.

L. neilgherrense var. *obovata* C. B. Clarke, in Fl. Brit. India, 3: 615, 1882; Cooke, T. 2: 119 (2: 181); Santapau, 399, 1962 & 302, 1963; Puri & Mahajan, 126.

L. neilgherrense Dalz. & Gibs. Bombay Fl. 159, 1861; (non Wight, 1848); Markham, 386; Nairne, 177; Cooke, T. 649; Birdwood, 17.

Common shrub all over Mahabaleshwar. Stem used for making walking sticks.

FLOWERS: August-November.

LOCAL NAME: Lokhandi.

Olea Linn.

1. **Olea dioica** Roxb., Fl. Ind. 1: 105, 1820; Graham, 109; Dalz. & Gibs. 159; Wight, Ill. 151; Lisboa, 216; Markham, 386; FBI 3: 612; Cooke, T. 648 & 2: 118 (2: 179); Birdwood, 17; Santapau, 398, 1962; Puri & Mahajan, 126.

One of the common trees at Mahabaleshwar. Very often infested by the parasite *Viscum*.

FLOWERS: January-April.

LOCAL NAMES: Par Jambhal, Karamba.

APOCYNACEAE

1. Plants armed with spines . . . . *Carissa*
1. Plants spineless 2
    2. Scandent shrubs or climbers 3
        3. Leaves in whorls . . . . *Allamanda*
        3. Leaves opposite . . . . *Anodendron*
    2. Erect shrubs or trees 4
        4. Leaves alternate 5
            5. Plants evergreen; fruit a drupe . . . . *Thevetia*
            5. Plants deciduous; fruits a pair of follicles . . . . *Plumeria*
        4. Leaves opposite or in whorls 6
            6. Leaves in whorls 7
                7. Leaves linear along whole length of branches; fruits elongated follicles . . . . *Nerium*
                7. Leaves oblanceolate or obovate, near the ends of the branches; fruits ellipsoid drupes . . . . *Rauwolfia*
            6. Leaves opposite 8
                8. Corolla with coronary scales . . . . *Wrightia*
                8. Corolla without coronary scales 9
                    9. Small garden herbs . . . . *Catharanthus*
                    9. Large shrubs or small trees 10
                        10. Plants deciduous; seeds cosmose, arillate . . . . *Holarrhena*
                        10. Plants evergreen; seeds with orange-red aril, not cosmose . . . . *Ervatamia*

Allamanda Linn.

1. **Allamanda cathartica** Linn., Mant. 2: 214, 1771; Cooke, T. 2: 144 (2: 207).

A. aubletii Pohl, Pl. Brass. 1:75, 1827; Graham, 116; Dalz. & Gibs. suppl. 53.

Cultivated ornamental shrub, flowering throughout the year.

LOCAL NAME: Bote.

Anodendron DC.

1. **Anodendron paniculatum** DC., Prodr. 8: 444, 1944; Dalz. & Gibs. 147; FBI 3: 668; Cooke, T. 2: 141 (2: 204); Birdwood, 18.

Echites paniculata Roxb., Fl. Ind. 2: 17, 1832; Wight, Icon. t. 396 (non Poir, 1812).

Gymnema nepalensis Graham, Cat. Bombay Pl. 120, 1839 (non Wight, 1824).

This species is included here on authority of Birdwood.

Carissa Linn. (nom. cons.)

1. **Carissa congesta** Wight, Icon. t. 1289, 1848; Hains, in Indian Forester, 45: 385, 1919.

C. carandas Graham, Cat. Bombay Pl. 116, 1839 (non Linn., 1767); Dalz. & Gibs., 143; FBI 3: 630 (pro parte); Cooke, T. 2: 124 (2: 186); Lisboa, 217; Birdwood, 17.

Common spiny shrub along Kelger Ghat. Ripe fruits are eaten and raw fruits are used for pickles.

FLOWERS: February-June.

LOCAL NAME: Carvanda.

Catharanthus G. Don

1. **Catharanthus roseus** (Linn.) G. Don, Gen. Syst. 4: 95, 1837; Graham, 115; Dalz. & Gibs. suppl. 53; Santapau, 147.

Vinca rosea Linn. Syst. Nat. ed. 10, 944, 1759; FBI 3: 640.

Lochnera rosea Reich., Consp. Regn. Veg. 134, 1828; Cooke, T. 2: 129 (2: 192).

An ornamental garden plant, bearing pink or white flowers.

FLOWERS: Throughout the year.

LOCAL NAME: Sadaphuli.

Ervatamia Stapf

1. **Ervatamia divaricata** (Linn.) R. Br., in Roem. & Schultes, Syst. 4: 420, 1819; Burkill, in Rec. Bot. Surv. India, 10: 320, 1925.

Nerium divaricatum Linn., Sp. Pl. 209, 1753.

N. coronarium Jacq., Coll. 1: 138, 1786; Bot. Mag. t. 1865.

E. coronaria (Jacq.) C. Stapf in This.-Dyer, Fl. Trop. Africa, 4: 127, 1902; Cooke, Γ. 2: 134 (2: 197).

T. coronaria Willd. Enum. Hort. Berol. 275, 1809; Graham, 115; Dalz. & Gibs. 144; FBI 3: 646; Wight, Icon. t. 477.

Cultivated for its flowers which are offered for religious worship.

LOCAL NAME: Tagar.

Holarrhena R. Br.

1. **Holarrhena antidysenterica** (Heyne ex Roth.) DC., Prodr. 8: 413, 1844; Dalz. & Gibs. 145; FBI 3: 644; Cooke, T. 2: 133 (2: 195): Birdwood, 18; Santapau, 287, 1963; Puri & Mahajan, 127.

Echites antidysenterica Heyne ex Roth., Nov. Pl. Sp. 138, 1821.

Wrightia antidysenterica Graham, Cat. Bombay Pl. 249, 1839 (excl. Syn.).

H. codaga G. Don, Gen. Syst. 4: 78, 1837; Wight, Icon. t. 1297, 1848.

Rare shrub in open forests on the ghat region.

FLOWERS: March-October.

LOCAL NAME: Kuda.

Nerium Linn.

1. **Nerium indicum** Mill., Gard. Dict. (ed. 8), no. 2, 1768; Santapau, 150.

N. odorum Soland, Apud. Ait. Hort. Kew. 1: 297, 1789; Graham, 114; FBI 3: 655; Cooke, T. 2: 143 (2: 206).

Ornamental garden plant.

FLOWERS: Throughout the year.

Plumeria Linn.

1. **Plumeria rubra** Linn., Sp. Pl. 209, 1753; Woodson, Ann. Missouri Bot. Garden, 25: 297, 1938.

P. acuminata R. Br., in Ait. Hort. Kew. ed 2, 2: 70, 1811; Graham, 119; Santapau, 149.

P. acutifolia Poir., in Lam. Encycl. Meth. Suppl. 2: 667, 1812; Dalz. & Gibs. suppl. 52; FBI 3: 641; Lisboa, 217; Cooke, T. 2: 142 (2: 206).

P. rubra Linn. forma *acuminata* (Ait.) Santapau & Irani ex Shah, in Journ. Univ. Bombay, 30: 35, 1962.

Cultivated in gardens and generally planted near temples.

FLOWERS: December-June.

LOCAL NAMES: Khair Champa, Deo-champa.

Rauwolfia Linn.

1. **Rauwolfia densiflora** (Wall. ex Ed-

ward) Benth. ex Hook. f., Fl. Brit. India, 3: 633, 1882; Nairne, 179; Cooke, T. 649 & 2: 127 (2: 189); Birdwood, 18; Santapau, 287, 1963; Puri & Mahajan, 127.

Tabernamontana densiflora Wall., in Edwards Bot. Reg. 15: t. 1273, 1829.

Ophioxylon neilgherrense Wight, Icon. t. 1292, 1848; Dalz. & Gibs. 144.

Quite common shrub in partially shaded places among the undergrowths near Lingmala and Tiger's path.

FLOWERS: March-April.

Thevetia Linn. (nom. cons.)

1. **Thevetia peruviana** (Pers.) K. Schum., in Pfam. 4(2): 159, 1895; Merrill, in Phil. Journ. Sci. Bot. 9: 130, 1914; Santapau, 150.

Cerbera peruviana Pers. Syn. 1: 267, 1805.

T. neriifolia Juss. ex Steud. Nom. ed 2, 2: 680, 1841.

Cultivated ornamental plant. Flowers are said to be very poisonous and only used for religious offering.

FLOWERS: Throughout the year.

LOCAL NAME: Karanda.

Wrightia R. Br.

1. **Wrightia tinctoria** R. Br., in Mem. Werm. Soc. 1: 47, 1811; Graham, 114; Dalz. & Gibs. 145; Lisboa, 217; Lee, 646; Birdwood, 18; Cooke, T. 2: 137 (2: 200).

A rare tree at Mahabaleshwar.

FLOWERS: March-June;

FRUITS: April-December.

ASCLEPIADACEAE

1. Pollen masses granular, solitary; filaments partlyor wholly free 2
    2. Corolla 4 mm long, lobes valvate .... *Hemidesmus*
    2. Corolla 10-15 mm long, lobes imbricate.................................. *Cryptolepis*
1. Pollen masses smooth, paired; filaments connate.................................. 3
    3. Plants with underground tubers; corolla lobes connate at tips.................... *Ceropegia*
    3. Plants without tubers; corolla lobes free.................................. 4
        4. Epiphytes; rooting at the nodes.................................. *Hoya*
        4. Terrestrial plants, not rooting at nodes.................................. 5
            5. Erect herbs or scandent shrubs.................................. 6
                6. Fleshy succulent plants, leafless when in flowers 7
                    7. Plants upright erect, less than 15 cm. long .... *Frerea*
                    7. Plants scandent, 2-3 metres long .... *Sarcostemma*
                6. Plants not succulent, leafy when in flowers 8
                    8. Plants erect 9
                        9. Stem and leaves glabrous; leaves lanceolate ....*Asclepias*
                        9. Stem and leaves cottony pubescent; leaves broadly ovate ....*Calotropis*
                    8. Scandent shrub ....*Gymnema*
            5. Twining climbers 10
                10. Pollen masses erect or horizontal 11
                    11. Corona lobes spreading; corolla green .... *Dregea*
                    11. Corona lobes adnate to the staminal column; corolla not green *Tylophora*
                10. Pollen masses pendulous 12
                    12. Corolla divided to half its length ....*Holostemma*
                    12. Corolla divided up to the base ....*Cynanchum*

Asclepias Linn.

1. **Asclepias curassavica** Linn. Sp. Pl. 215, 1753; Edward, Bot. Rot. Reg. t. 81, 1815; Graham, 120; Dalz. & Gibs. suppl. 54; FBI 4: 18; Cooke, T. 2: 180 (2: 245); Santapau, 178.

Rare weed on banks of rivers and streams. Sometimes cultivated in gardens.

FLOWERS: Throughout the year.

Calotropis Linn.

1. **Calotropis gigantea** (Linn.) R. Br., in Ait. Hort. Kew. ed. 2, 78, 1811; Edward, Bot. Reg. t. 58, 1815; Wight, Ill. tt. 155, 156A; Graham, 120; Dalz. & Gibs. 149; Bot. Mag. t. 6862; FBI 4: 17; Lisboa, 217; Birdwood, 18; Cooke, T. 2: 151 (2: 214); Santapau, 171.

Asclepias gigantea Linn. Sp. Pl. 214, 1753.

Rare shrub in waste-lands. Leaves offered for worship.

FLOWERS: Throughout the year.

Ceropegia Linn.

1. Stems erect .... *C. lawii*
1. Stems twining 2
   2. Corolla lobes as long as the tube......... .... *C. vincaefolia*
   2. Corolla lobes ± 1/3 length of the tube... .... *C. hirsuta*

1. **Ceropegia hirsuta** Wight & Arn., in Wight, Contrib. 30, 1834; FBI 4: 71; Cooke, T. 2: 137 (2: 242); Blatter & McCann, in Journ. Bombay nat. Hist. Soc. 36: 535, 1933; Santapau, 177; Santapau & Irani, Bull. Bot. Soc. Bengal 12 (1 & 2): 10-11, 1958.

C. hispida Blatter & McCann, in Journ. Bombay nat. Hist. Soc. 35: 409, 1931.

Rare species on rocky ground on way to Panchgani.

FLOWERS: July-August.

2. **Ceropegia lawii** Hook., in Bot. Mag. t. 4093, 1844; FBI 4: 72; Cooke, T. 2: 177 (2: 240); Blatter & McCann 36: 535; Santapau, 176; Huber, in Mem. Soc. Broter 12: 64, t. 3, f. 31, 1957.

Quite common species at Lingmala, among the undergrowth in shady places.

FLOWERS: July-October.

3. **Ceropegia vincaefolia** Hook. f., Bot. Mag. t. 3740, 1839; Ansari, in Bull. Bot. Surv. India, 13: 190, 1971.

C. hirsuta var. *vincaefolia* Hook. f., in Fl. Brit. India 4: 74, 1883.

C. polyantha Blatter & McCann, in Journ. Bombay nat. Hist. Soc. 34: 936, 1931 & 36: 535, 1933.

C. oculata var. *subhirsuta* Huber, in Mem. Soc. Broter, 12: 65, 1952.

Rare species found at Lingmala and near Venna Lake.

FLOWERS: July-October.

Cryptolepis R. Br.

1. **Cryptolepis buchanani** Roem. & Schultes, Syst. 4: 409, 1819; Graham, 113; Dalz. & Gibs. 148; Wight, Icon. t. 194; FBI 4: 5; Cooke, T. 2: 147 (2: 210); Puri & Mahajan, 127; Santapau, 151.

Rare. Only reported by Puri and Mahajan.

FLOWERS: April-June.

Cynanchum Linn.

1. **Cynanchum callialata** Ham., in Wight, Contrib. 56, 1834; Wight, Icon. t. 1279; FBI 4: 24; Cooke, T. 2: 157 (2: 221); Santapau, 152.

A rare climber near Lingmala.

FLOWERS: September-December.

Dregea E. Meyer (nom. cons.)

1. Suberect undershrubs; leaves lanceolate; pedicels more or less 1 cm. long................. .... *D. angustifolia*
1. Climbing shrubs; leaves broadly ovate; pedicels ± 3 cm: long...................*D. volubilis*

1. **Dregea angustifolia** (Hook. f.) Santapau & Irani, in Bot. Mem. Univ. Bombay 4: 41, 1900.

D. volubilis var. *angustifolia* Hook. f., in Fl. Brit. India, 4: 47, 1883; Birdwood, 18.

Marsdenia volubilis var. *angustifolia* Blatter & McCann, Journ. Bombay nat. Hist. Soc. 36: 167, 1904.

This species is reported by Birdwood from Rotunda Ghat and Babington point.

FLOWERS: May-June.

LOCAL NAME: Dudhli.

2. **Dregea volubilis** (Linn. f.) Benth. ex Hook. f., in Fl. Brit. India, 4: 56, 1883; Talbot 2: 254; Birdwood, 18; Santapau, 154.

Asclepias volubilis Linn. f. suppl. 170, 1781.

Marsdenia volubilis Cooke, T., Fl. Pres. Bombay. 2: 166, 1904; FBI 4: 47; Santapau, 289, 1960; Puri & Mahajan, 127.

Hoya viridiflora R. Br., in Mem. Wern. Soc. 1: 27, 1809; Graham, 119; Wight, Icon. t. 586; Dalz. & Gibs. 153; Lisboa.

Wattakaka volubilis (Linn. f.) Stapf, in Curtis Bot. Mag. sub. t. 8976, 1923.

Climbing shrub, frequent near Lingmala.

FLOWERS: April-June; FRUITS: August-October.

LOCAL NAMES: Dhora, Amri, Hirandoti.

Frerea Dalz.

1. **Frerea indica** Dalz., in Journ. Linn. Soc. London, 8: 10, t. 3, 1865; FBI 4: 76; Blatter & McCann, 36: 535; McCann, Journ. Bombay nat. Hist. Soc. 41: 143, tt. 1-3, 1939.

Only Bishop R. D. Acland has reported to have seen this species among the rocks near Kate's point.

FLOWERS: September-December.

FRUITS: December-January.

Gymnema R. Br.

1. **Gymnema sylvestre** (Retz.) R. Br. ex Schultes, in Roem. & Schult. Syst. Veg. 6: 57, 1819; Wight, Icon. t. 349; Graham, 120; Dalz. & Gibs. 151; FBI 4: 29; Cooke, T. 649 & 2: 160 (2: 224); Lisboa, 217; Talbot 2: 249; Blatter & McCann, 36: 530; Birdwood, 18; Santapau, 288, 1963; Puri & Mahajan, 127.

Periploca sylvestris Retz., Obs. 2: 15, 1781.

Common plant in open forests. Leaves used by local people as antidiabetic drug.

FLOWERS: April-May;

FRUITS: September-January.

LOCAL NAMES: Kauli, Lamtani, Dodi, Pitani, Sirdoli.

2. **Gymnema montanum** (Roxb.) Hook. f., Flora Brit. India, 4: 31, 1883; Cooke, T. 649, 1885; Blatter & McCann, 36: 530.

Asclepias montana Roxb., Fl. Ind. 2: 45, 1832.

This species is reported by T. Cooke, in vegetation of Mahabaleshwar (1885). But he has not recorded it from Mahabaleshwar later in Flora of Bombay Presidency.

Hemidesmus R. Br.

1. **Hemidesmus indicus** Schultes, in Roem. & Schult. Syst. Veg. 6: 126, 1819; FBI 4: 5; Graham, 122; Wight, Icon t. 594; Dalz. & Gibs. 147; Cooke, T. 2: 147 (2: 210); Talbot 232; Santapau & Irani, 94; Santapau, 289, 1963.

Periploca indica Linn. Sp. Pl. 211, 1753.

Frequent in the forest among undergrowth.

FLOWERS: July-January; FRUITS: January-May.

LOCAL NAME: Anantmul.

Holostemma R. Br.

1. **Holostemma annulare** (Roxb.) K. Schum., in Pfam. 4(2): 250, f. 71J-K, 1895; Santapau, 171.

Asclepias annularia Roxb., Fl. Ind. 2: 37, 1832.

H. rheedei Wall. Pl. As. Rar. 2: 51. 1851; Wight, Icon. t. 597; Graham, 121; Dalz. & Gibs. 148; FBI 4: 21; Talbot, 2: 245.

H. rheedeianum Cooke, T. Fl. Pres. Bombay 2: 156, 1904 (non Spreng., 1825).

Rare climber at Mahabaleshwar.

Hoya R. Br.

1. **Hoya pendula** Wight & Arn., in Wight Contrib. 36: 1834 (excl. syn.; non Wight, Icon. t. 474, 1840); Santapau, Journ. Bombay nat. Hist. Soc. 53: 504, 1956.

H. pallida Dalz. & Gibs. Bombay Fl. 152, 1861.

H. wightii Hook. f., Fl. Brit. India, 4: 59, 1883;

Nairne, 186; Cooke, T. 2: 169 (2: 234); Talbot 2: 258; Santapau, 155.

H. parasitica Graham, Cat. Bombay Pl. 119, 1839 (non Wall., 1830).

Common climber near Lodwick point, Lingmala.

FLOWERS: May-August;

FRUITS: August-January.

LOCAL NAMES: Amri, Dudhyal.

Sarcostemma R. Br.

1. **Sarcostemma acidum** (Roxb.) Voigt, Hort. Sub. Calcattensis, 542, 1845; Blatter & McCann, 36: 529; Santapau & Irani, 76.

Asclepias acida Roxb., Fl. Ind. 2: 31, 1832.

S. brevistigma Wt. & Arn., in Wight Contrib. 59, 1834; Wight, Icon. t. 595; Dalz. & Gibs. 149; FBI 4: 26; Lisboa, 217; Talbot 247.

This species is included here on the authority of Lisboa. We have not seen it on Mahabaleshwar plateau, though it is common between Panchgani and Wai.

FLOWERS: June-July.

LOCAL NAMES: Somalata, Somvel.

Tylophora R. Br.

1. **Tylophora dalzellii** Hook. f., Fl. Brit. India 4: 43, 1883; Nairne, 185; Cooke, T. 2: 163 (2: 227); Blatter & McCann, 36: 531; Santapau, 289, 1963; Puri & Mahajan, 127; Santapau, 154.

T. carnosa Dalz. & Gibs., Bombay Fl. 150, 1861 (non Wight, 1834).

A rare species at Mahabaleshwar.

FLOWERS: April-November.

BUDDLEJACEAE

Buddleja Linn.

1. **Buddleja asiatica** Lour., Fl. Cochinch. 72, 1790; Dalz. & Gibs. 180; Lisboa, 218; Birdwood, 18; Nairne, 188; Cooke, T. 2: 183 (2: 248); Puri & Mahajan, 127.

Rare species in Fitzgerald Ghat and at Bhilar Estate.

FLOWERS: January-April.

GENTIANACEAE

1. Flowers regular 2
 2. Ovary 2-celled .... *Exacum*
 2. Ovary 1-celled 3
  3. Corolla with 1-2 glands at base on inner side .... *Swertia*
  3. Corolla glandular inside.... *Centaurium*
1. Flowers irregular .... *Canscora*

Canscora Lam.

1. Stem not winged .... *C. diffusa*
1. Stems winged 2
 2. Sepals strongly keeled ..... *C. khandalensis*
 2. Sepals not keeled .... *C. decurrens*

1. **Canscora decurrens** Dalz., in Kew J. Bot. 2: 136, 1850; Dalz. & Gibs. 157; FBI 4: 103; Cooke, T. 2: 192 (2: 257)

There are two specimens of this species in Blatter Herbarium from Mahabaleshwar, without collection locality data.

FLOWERS: October-December.

2. **Canscora diffusa** (Vahl) R. Br., Prodr. 45, 1810 (in obs.); Graham, 123; Dalz. & Gibs. 158; FBI 4: 103; Nairne, 191; Cooke, T. 650 & 2: 191 (2: 257); Lisboa, 218; Birdwood, 19; Lee, 646; Santapau, 400, 1962; Puri & Mahajan, 127.

Gentiana diffusa Vahl, Sym. Bot. 3: 47, 1794.

C. lawii Wight, Icon. t. 1327, 1848 (non Clarke, 1875).

Common and abundant plant in moist rocky places with bright-red flowers. Plants have been collected from Chinaman's Falls & Fitzgerald Ghat.

FLOWERS: October-January.

3. **Canscora khandalensis** Santapau, in Kew Bull. 1948: 485, 1949; Fl. Khandala, 162.

There is only one specimen of this species from Mahabaleshwar, collected and identified by Rev. Fr. H. Santapau, from sides of Venna Lake. This specimen is a young plant.

Centaurium Hill.

1. **Centaurium centauroides** (Roxb.) Rolla Rao & Hemadr, in Journ. Bombay nat. Hist. Soc. 67: 357, 1970.

Chironia centauroides Roxb. Fl. Ind. 2: 283, 1824.

Erythraea roxburghii D. Don, Syst. 4: 206, 1837; Wight, Icon. t. 1325; Dalz. & Gibs. 157; Cooke, T. 2: 190 (2: 255).

Common herb in drying rice-fields near Chinaman's Falls.

FLOWERS: October-May.

Exacum Linn.

1. Calyx not winged on the back.......... *E. lawii*
1. Calyx winged on the back.................. 2
    2. Leaves petioled.............. *E. carinatum*
    2. Leaves sessile 3
        3. Corolla more than 2 cm. long........ .... *E. bicolor*
        3. Corolla less than 1 cm. long .... *E. pumilum*

1. **Exacum bicolor** Roxb., Fl. Ind. 1: 413, 1820; Graham, 123; Dalz. & Gibs. 156; Wight, Icon. t. 1321; FBI 4: 96; Cooke, T. 2: 187 (2: 252); Birdwood, 18; Santapau, 401, 1962.

Sebaea carinata Graham, Cat. Bombay Pl. 124, 1839 (non Spreng., 1824).

This species is included on authority of Rev. Fr. H. Santapau.

2. **Exacum lawii** Clarke, in Fl. Brit. Ind. 4: 98, 1883; Woodrow, in Journ. Bombay nat. Hist. Soc. 12: 168, 1898; Birdwood, 18; Cooke, T. 650, 1885 & 2: 180 (2: 254); Puri & Mahajan, 127.

Rare species among the grasses at Lodwick point and Kate's point. Flowers bright gentian blue.

FLOWERS: September-October.

LOCAL NAMES: Jatali, Gaulan.

3. **Exacum carinatum** Roxb., Fl. Ind. 1: 415, 1820; T. P. Ramamurthy, in Fl. Hassan Dist. 425, 1978.

E. petiolare Griseb. in DC. Prodr. 9: 46, 1845; Wight Icon. t. 1324 (2), 1848; Dalz. & Gibs. 157; FBI 4: 98; Puri & Mahajan, 127.

E. pedunculatum Linn. var. *petiolare* Trim., Fl. Ceylon, 3: 182, 1895: Cooke, T. 2: 188 (2: 253).

This species is included on authority of Puri & Mahajan.

FLOWERS: October-December.

4. **Exacum pumilum** Griseb., in DC. Prodr. 9: 46, 1845; Wight, Icon. t. 1324; Dalz. & Gibs. 157; FBI 4: 68; Cooke, T. 2: 188 (2: 254); Santapau, 401, 1962.

Common herb among grasses. Flowers bluish purple in colour.

FLOWERS: August-October.

Swertia Linn.

1. Petal with two glands at the base......*S. minor*
1. Petals with single gland at the base.......... .... *S. densiflora*

1. **Swertia densiflora** (Griseb.) Kashyapa, in Kew Bull. 15: 42, 1961.

Ophelia densiflora Griseb., in DC. Prodr. 9: 125, 1845.

S. decussata Nimmo, in Graham, Cat. Bombay Pl. 249, 1839; (nomen nudum) Birdwood, 19; Nairne, 192; Cooke, T. 650, 1885 & 2: 194 (2: 259).

O. alba Arn., in Wight Ill. t. 157, f. 3F, 1850.

O. multiflora Dalz., in Hook. Kew Journ. 2: 135, 1850; Dalz. & Gibs. 156; Lisboa, 218.

Quite a common plant at Mahabaleshwar. Roots are used in medicine as bitter tonic and sold in Mahabaleshwar Market.

FLOWERS: December-January.

2. **Swertia minor** (Griseb.) Knobl., in Bot. Centralbl. 60: 321, 1894; Cooke, T. 2: 193 (2: 259); Santapau, 296, 1963.

Ophelia minor Griseb., in DC. prodr. 9: 126, 1845; Wight, Icon. t. 1332; Dalz. & Gibs. 156.

Pleurogyne minor Benth., Gen. Pl. 2: 816, 1876; FBI 4: 120.

Rare species among the grasses with pale mauve flowers. Collected only from Kate's point.

FLOWERS: September.

Boraginaceae

1. Prostrate or procumbent herbs........*Coldenia*
1. Erect herbs 2
   2. Fruits smooth ....*Mattiastrum*
   2. Fruits glochidiate 3
      3. Nutlets base not produced downwards... .... *Adelocaryum*
      3. Nutlets base produced downwards....... .... *Cyanoglossum*

Adelocaryum Brandis

1. Stem red; flowers pale blue with dark centre. .... *A. coelestinum*
1. Stem green; flowers uniformly dark-blue....... .... *A. malabaricum*

1. **Adelocaryum coelestinum** (Lindl.) Brand., in Fedde Repert. 13: 549, 1915 & Pfreich, 78: 78, t. 8, 1921; Santapau, 290, 1963; Puri & Mahajan, 127.

Cyanoglossum coelestinum Lindl., in Bot. Reg. 25: t. 36, 1839; Dalz. & Gibs. 173; Lisboa, 218.

Echinospermum coelestinum Wight, Icon. t. 1394, 1850.

Paracarym coelestinum Benth. & Hook. f., Gen. Pl. 2: 850, 1878; Birdwood, 19; FBI 4: 160; Nairne 197; Cooke, T. 650, 1885 & 2: 218 (2: 285); Lee, 646.

Fairly common and abundant, often gregarious on forest fringes and on exposed grassy slopes along road-sides. Plants bear cauline as well as radical leaves. Mahabaleshwar specimens come from Chinaman's falls, Wilson point, Fitzgerald ghat, Venna lake, Petit Road, Madhu Kosh and Pratapsingh Park.

FLOWERS: August-April.

2. **Adelocaryum malabaricum** (Clarke) Brandis, in Fedde Repert. 13: 549, 1915 & Pfreich. 78: 79, 1921.

Paracaryum malabaricum Clarke, in Flora Brit. India 4: 160, 1883; Birdwood, 19; Cooke, T. 650, 1885 & 2: 219 (2: 286); Santapau, 399, 1962 & 290, 1963.

Very common and abundant weed all over in latter half of monsoon. It is more abundant near Venna Lake, Chinaman's Falls, Wilson point, Kate's point.

FLOWERS: August-December.

Coldenia Linn.

1. **Coldenia procumbens** Linn. Sp. Pl. 125, 1753; Graham, 135; Dalz. & Gibs. 171; Lisboa, 218; FBI 4: 144.

This species is included on the authority of Lisboa.

FLOWERS: September-October.

Cyanoglossum Linn.

1. Flowers in racemes; pedicels long, filiform, longer than calyx ....*C. wallichii*
1. Flowers capitate or paniculate; pedicels short, shorter than calyx.........*C. zeylanicum*

1. **Cyanoglossum wallichii** G. Don, Gen. Syst. 4: 354, 1838; FBI 4: 157.

C. glochidiatum Wall. ex Lindley, in Bot. Reg. 27: t. 15, 1841; FBI 4: 156.

C. denticulatum DC., Prodr. 10: 150, 1845; FBI 4: 157.

Fairly common herb along margins of forests.

FLOWERS: June-November.

2. **Cyanoglossum zeylanicum** (Vahl ex Hornem.) Thunb. ex Lehm. Neue Schriften Naturf. Ges. Halle. 3(2): 20, 1817; Kazmi, J. Arnold Arbor. 52: 344, 1971.

Anchusa zeylanica Vahl ex Hornem., Enum. Hafn. 3, 1807.

C. denticulatum var. *zeylanicum* (Thunb.) C. B. Clarke, in Flora Brit. Ind. 4: 157, 1883; Cooke, T. 2: 217 (2: 284).

C. meeboldii Brandis, in Fedde Repert. 14: 323, 1916 & in Pfreinch. 72: 134, 1921; Santapau, 166; Puri & Mahajan, 127.

Included on the authority of Puri & Mahajan only.

FLOWERS: July-August.

Mattiastrum Brandis

1. **Mattiastrum lambertianum** (Clarke) Brandis, in Pfreich. 78: 61, 1921; Santapau, 291, 1963.

Paracaryum lambertianum Clarke, in Fl. Brit. India 4: 161, 1883; Birdwood, 19; Nairne, 197;

Cooke, T. 650 & 2: 219 (2: 287); Puri & Mahajan, 127.

Fairly common on hill slopes among grasses in the latter half of the monsoon. Abundant at Dhobi's Falls and Fitzgerald ghat. So far this species seems to be endemic to Mahabaleshwar.

FLOWERS: October-November.

EHRETIACEAE

Rotula Lour.

1. **Rotula aquatica** Lour. Fl. Cochinch. 121, 1790; Santapau, 164.

Rhabdia lycioides Mart. Nov. Gen. Sp. 2: 137, 1826; FBI 4: 145; Cooke, T. 2: 205 (2: 272).

R. viminea Dalz., in Hook. Icon. t. 823, 1854; Dalz. & Gibs. 170.

Ehretia cuneata Wight, Icon. t. 1385, 1848.

In Poona (BSI) Herbarium there is one specimen collected by Cooke from Koyna Valley, below Mahabaleshwar. But we have not seen this plant on Mahabaleshwar plateau.

CONVOLVULACEAE

1. Outer three or all sepals much enlarged in fruit corolla tube uniformly enlarged from the base to the apex .... *Porana*
1. Sepals not enlarged in fruit; corolla tube not uniformly enlarged 2
   2. Fruit dehiscent .... *Ipomoea*
   2. Fruit indehiscent .... *Argyreia*

Argyreia Lour.

1. Bracts small, scaly, foliaceous ...... *A. elliptica*
1. Bracts large, membranous 2
   2. Leaves elongate-ovate, rounded at the base .... *A. involucrata*
   2. Leaves broadly ovate, cordate at base .... *A. boseana*

1. **Argyreia boseana** Santapau & Patel, in Trans. Bose Res. Inst. Calcutta, 22: 35, t. 3, 1958.

A. hookeri Cooke, T. Fl. Pres. Bombay 2: 255, 1905, (non Clarke, 1883); Talbot 2: 285; Santapau, 293. 1963; Puri & Mahajan, 127.

A. malabarica Woodrow, in Journ. Bombay nat. Hist. Soc. 12: 170, 1898.

Fairly common climber on forest trees. Flowers mauve-violet. This species is endemic to Mahabaleshwar and Panchgani.

FLOWERS: August-October.

2. **Argyreia elliptica** (Roth.) Choisy, in Mem. Soc. Phys. Genere 6: 417, 1833; Graham, 128; Dalz. & Gibs. 169; Santapau, 293, 1963; Puri & Mahajan, 128.

Ipomoea elliptica Roth., Pl. Sp. 113, 1821.

Lettsomia elliptica (Roth.) Wight ex C. B. Clarke, in Fl. Brit. India 4: 192, 1883; Cooke, t. 2: 259 (2: 329).

Occasional twiner on forest trees.

FLOWERS: September-October.

LOCAL NAME: Bondvel.

3. **Argyreia involucrata** Clarke, in Fl. Brit. India. 4: 187, 1883; Talbot 2: 256; Cooke, T. 2: 256 (2: 325).

A. involucrata var. *inaqualis* Clarke, in Fl. Brit. India 4: 187, 1883.

This plant has been reported by Cooke, T., from Wada, below Mahabaleshwar. But it is not found on the plateau.

FLOWERS: July-August.

Ipomoea Linn.

1. Sepals entirely glabrous........... *I. diversifolia*
1. Sepals hairy on outer side.................. 2
   2. Sepals not long-attenuate at apex......... .... *I. illustris*
   2. Sepals long-attenuate or linear-acuminate at apex .... *I. congesta*

1. **Ipomoea congesta** R. Br., Prodr. 485, 1810; Oostsroom, in Blumea 3: 500, 1940.

I. acuminata (Vahl) Roem. & Schultz, Syst. 4: 228, 1819 (non Ruiz & Pav., 1799).

Convolvulus acuminatus Vahl, Symb. Bot. 3: 26, 1794.

I. learii Paxt., Bot. Mag. 6: t. 267, 1839, Cooke, T. 2: 251 (2: 321).

Cultivated plant with dark blue flowers which fade to reddish colour. Occasionally seen in private gardens.

2. **Ipomoea diversifolia** R. Br. Prodr. 487, 1810; Oostsroom, 365; Santapau, 170.

Pharbitis laciniata Dalz. in Kew Journ. Bot. 3: 178, 1851; Dalz. & Gibs. 167.

I. laciniata Clarke, in Fl. Brit. India, 4: 200, 1883; Cooke, T. 2: 250 (2: 319); Puri & Mahajan, 128.

I. dissecta Woodrow, in Journ. Bombay nat. Hist. Soc. 12: 171, 1898 (non Willd.,); Birdwood, 19.

Rare plant on grassy slopes. Prostrate or ascending but not climbing or twining.

FLOWERS: October-November.

3. **Ipomoea illustris** Prain, Bengal Pl. 735, 1903; Oostsroom, in Blumea, 3: 566, 1940; Santapau, 170.

I. companulata Choisy, in Mem. Soc. Phys. Geneve 6: 151, 1833; Wight, Icon. t. 1375; Dalz. & Gibs. 165; FBI 4: 211; Cooke, T. 2: 247 (2: 316); Lee, 646 (non Linn. 1753).

I. companulata var. *illistris* Clarke, in Fl. Brit. India, 4: 211, 1883.

I. soluta Kerr, in Kew Bull. 1941: 18, 1941.

FLOWERS: January-February.

Porana Burm.

1. **Porana racemosa** Roxb., Fl. Ind. 2:41, 1824; Graham, Cat. 133; Dalz & Gibs. 167; Oostsroom, in Blumea 3: 91, 1938; FBI 4: 222; Santapau, 167.

P. malabarica Clarke, in Fl. Brit. Ind. 4: 223, 1883; Nairne, 206; Cooke, T. 651 & 2: 226 (2: 294); Birdwood, 19; Puri & Mahajan, 128.

Fairly common climber on forest trees.

FLOWERS: October-November.

LOCAL NAME: Bhauri.

SOLANACEAE

1. Fruit a capsule 2
    2. Stamens 4 .... *Browallia*
    2. Stamens 5 3
        3. Stamens all 5 perfect .... *Datura*
        3. Stamens in 2 pairs and one much smaller or rudimentary .... *Petunia*
1. Fruit a berry 4
    4. Fruiting calyx persistant, highly accrescent 5
        5. Flowers pale or light blue....... *Nicandra*
        5. Flowers yellow .... *Physalis*
    4. Fruiting calyx not accrescent............. 6
        6. Anthers dehiscing by apical pores........7
            7. Anthers linear; flowers in cymes...... .... *Solanum*
            7. Anthers ellipsoid; flowers in fascicles .... *Lycianthus*
        6. Anthers dehiscing by longitudinal slits...8
            8. Corolla tubular ....*Cestrum*
            8. Corolla rotate 9
                9. Flowers yellow........*Lycopersicon*
                9. Flowers white ....*Capsicum*

Browallia Linn.

1. Calyx not glandular ....*B. americana*
1. Calyx glandular, viscid...............*B. viscosa*

1. **Browallia americana** Linn., Sp. Pl. 631, 1753; Bailey, Man. Cult. Pl. 880.

B. demissa Linn., Syst. ed 10, 1118, 1759; Dalz. & Gibs. suppl. 63; Cooke, T. 2: 276 (2: 346); Vartak, in Journ. Univ. Poona, 18: 91, 1960.

B. elata Linn. Syst. ed 10, 118, 1759.

Dr. V. D. Vartak has reported this species from Mahabaleshwar. One of the specimens which we have examined (Vartak-2020) is *B. viscosa* H. B. K.

2. **Browallia viscosa** H. B. K., Nov. Gen. Sp. Pl. 2: 373, 1818; Bailey, 880.

Viscous, glandular hairy herbs with axillary flowers which are blue or violet purple in colour. Cultivated but very often found as an escape.

FLOWERS: December.

Capsicum Linn.

1. **Capsicum annum** Linn. var. **acuminatum** Fingerh. Mon. Capsicum 13, t. 2, f.c., 1832; Cooke, T. 2: 276 (2: 347); Santapau, in Journ. Bombay nat. Hist. Soc. 47: 661, 1948.

C. frutescens Roxb. Fl. Ind. 1: 574, 1832 (non Linn., 1753); Graham, 139; Dalz. & Gibs. suppl. 61; FBI 4: 239.

Cultivated for fruits which are used as spices and condiments.

FLOWERS: Throughout the year.

LOCAL NAME: Mirchi, Lal mirchi

Cestrum Linn.

1. Calyx lobes distinctly reflexed........*C. diurnum*
1. Calyx lobes erect or spreading, not reflected ....*C. nocturnum*

1. **Cestrum diurnum** Linn. Sp. Pl. 191, 1753; Bailey, 873; Bor & Raizada, some Beaut. Ind. Climb. & Schrubs 118, 1954.

Cultivated in gardens. Flowers ivory-white in colour.

FLOWERS: Throughout the year.

LOCAL NAME: Din-ka-Raja.

2. **Cestrum nocturnum** Linn. Sp. Pl. 191, 1753; Bor & Raizada, 119; Bailey, 873; Santapau, 200; Puri & Mahajan, 128.

Cultivated ornamental plant. Produces strong fragrance during night and in early morning, which fades away after sun-rise.

FLOWERS: June-July.

LOCAL NAME: Rat-ki-Rani.

Datura Linn.

1. Flowers erect; fruits spiny 2
   2. Fruits drooping ....*D. metel*
   2. Fruits erect ....*D. stramonium*
1. Flowers drooping; fruits not spiny.. *D. suaveolens*

1. **Datura suaveolens** Humbolt & Bonaplant ex Willd., Enum. Hort. Berol. 227, 1809; Bor & Raizada, Some Beaut. Indian Climb. & Shrubs 130, 1954;

Brugmansia candida (non Pers. 1805); Graham, Cat. Bombay Pl. 141; 1839; Dalz. & Gibs. suppl. 63; Birdwood, 19; Nairne, 210; Cooke, T. 649, 1885.

B. suaveolens Bercht. & Presl. ex G. Don, Gen. Syst. 4: 475, 1838.

Datura arborea Cooke, T., Fl. Presidency Bombay 2: 274, 1905 (2: 344); (non Linn., 1753).

Fairly common tall shrub along roadsides and in wastelands with trumpet-shaped drooping flowers. It rarely produces fruits in Mahabaleshwar.

FLOWERS: May-July; FRUITS: December.

2. **Datura metel** Linn. Sp. Pl. 179, 1753; Cooke, T. 2: 273 (2: 349); Santapau, Journ. Bombay nat. Hist. Soc. 47: 657; Bailey, 877; Bor & Raizada, l. c. 129.

D. fastuosa Linn. Syst. ed 10, 2: 932, 1759; FBI 4: 242; Cooke, T. 651 & 2: 273 (2: 343).

D. alba Nees, in Trans. Linn. Soc. 17: 73, 1834; Graham, 141; Wight, Icon. t. 852; Dalz. & Gibs. 174; Lisboa, 218.

D. fastuosa Linn. var. *alba* (Nees) Clarke, in Fl. Brit. India 4: 243, 1883; Cooke, T. 2: 273 (2: 344); Birdwood, 19.

This species is included on authority of Lisboa and Birdwood.

3. **Datura stramonium** Linn. Sp. Pl. 179, 1753; FBI 4: 242; Wettst, in Pfam. 4 (3b) 27, f. 13A-C, E-J, 1891.

D. tatula Linn. Sp. Pl. 256, 1762.

D. stramonium Linn. var. *tatula* Clarke, in Fl. Brit. India, 4: 242, 1883.

Occasional annual herb along roadsides in wastelands.

FLOWERS: June-July. FRUITS: September.

Lycianthus Hassl.

1. Calyx entire or obscurely 5-toothed....*L. laevis*
1. Calyx 5-8 conspicuous teeth...........*L. laevis* var. *kaitisis*

1. **Lycianthus laevis** (Dunal) Bitter, Abh. Nat. Ver. Bremen. 24: 484, 1920; Baker & Bakh. Fl. Java 2: 476, 1955.

Solanum laeve Dunal, Solan. Synop. 22, 1816.

S. bigeminatum Nees in Trans. Linn. Soc. London, 17: 42, 1837; FBI 4: 231; Woodrow, in Journ. Bombay nat. Hist. Soc. 12: 173, 1898; Cooke, T. 2: 264 (2: 334); Puri & Mahajan, 128; Santapau, 47: 656.

L. bigeminata (Nees) Bitter, in Abn. Naturh. ver. Bremen. 24: 480, 1920.

S. neesianum Dalz. & Gibs., Bombay Fl. 175, 1861. (non Wall. ex Nees, 1837).

This species is included on the authority of Woodrow, T. Cooke and Puri & Mahajan. No reliable specimens were seen by us. Following subspecies of this species is quite common at Mahabaleshwar and might have been mistaken for the typical subspecies.

2. **Lycianthus laevis** (Dunal) Bitter, subsp. **kaitisis** (Bitter). comb. nov.

L. bigeminata (Nees) Bitter, subsp. *kaitisis* (Dun.) Bitter, in Abh. Naturn. Ver. Bremen 24: 481, 1920; Santapau, 47: 656.

S. kaitisis Dunal, in DC. Prodr. 13(1): 157, 1852.

S. denticulatum Clarke, in Fl. Brit. India, 4: 231, 1883 (non Blume, 1825); Wight, Icon. t. 1397, 1848; Cooke, T. 640 & 2: 264 (2: 334); Birdwood, 19; Puri & Mahajan, 128.

Common along roadsides and at the edges of forests.

FLOWERS: July-October;

FRUITS: August-December.

Lycopersicon Mill.

1. **Lycopersicon lycopersicum** (Linn.) Karst. ex Farwell, Ann. Rep. Comm. Park Boulewards Detr. 11: 83, 1900; G. L. Shah, Fl. Gujarat, 486, 1978.

L. esculentum Mill., Gard Dict. ed 8, No. 2, 1768; FBI 4: 237; Cooke, T. 2: 275 (2: 345); Santapau, 47: 660.

Solanum lycopersicum Linn. Sp. Pl. 185; Dalz. & Gibs. suppl. 61.

Occasionally in waste-lands along roadsides. Usually cultivated for its fruits.

FLOWERS & FRUITS: Throughout the year.

LOCAL NAMES: Tamatar, Tomato.

Nicandra Adans.

1. **Nicandra physaloides** (Linn.) Gaertn., Fruct. 2: 237, t. 141, f. 2, 1791; Graham, 140; Dalz. & Gibs. suppl. 62; FBI 4: 240; Cooke, T. 2: 275 (2: 346); Santapau, 47: 660; Birdwood, 19.

Occasionally found in waste-lands along roadsides. Very showy plant when in bloom.

FLOWERS: July-August.

Nicotiana Linn.*

1. Corolla tube linear .... *N. plumbaginifolia*
1. Corolla tube narrow below, ventricose above .... *N. tabacum*

* Cultivated or Escape.

1. **Nicotiana plumbaginifolia** Viv. Elench. Pl. Hort. Dinegro 26, t. 5, 1820; G. L. Shah, Fl. Gujarat, 487, 1978.

Rare weed along roadsides and in gardens.

FLOWERS: November-January.

2. **Nicotiana tabacum** Linn. Sp. Pl. 180, 1753; Graham, 140; Dalz. & Gibs. suppl. 63; FBI 4: 245; Lisboa, 219; Cooke, T. 2: 276 (2: 346); Santapau, 47: 660.

Rarely cultivated in gardens.

FLOWERS & FRUITS: December-April.

LOCAL NAME: Tambakhu.

Petunia Juss.

1. **Petunia violacea** Lindl., Bot. Reg. t. 1626, 1853; Dalz. & Gibs. suppl. 63.

Cultivated in gardens in cold seasons. Sometimes found wild as an escape from cultivation.

FLOWERS: January-February.

Physalis Linn.

1. Stems glabrous; anthers yellow .... *P. minima*
1. Stems pubescent with appressed hairs, anthers greenish-blue .... *P. longifolia*

1. **Physalis longifolia** Nutt., in Trans. Amer. Phil. Soc. ser. 2, 5: 193, 1834; Santapau, 174.

P. peruviana Graham, Cat. Bombay pl. 140, 1839 (non Linn., 1753); Dalz. & Gibs. suppl. 61; FBI 4: 238; Santapau, 47: 657; Lisboa, 219.

P. pubescens R. Br. Prodr. 1: 447, 1810 (non Linn., 1753).

Rare weed in wastelands. This species goes under *P. peruviana* in our herbarium materials. According to Rev. Fr. H. Santapau, *P. peruviana* is a shrub or small tree, whereas the Mahabaleshwar plant is a herbaceous weed.

FLOWERS: November.

LOCAL NAME: Popti.

2. **Physalis minima** Linn. Sp. Pl. 183, 1753; FBI 4: 238; Graham, 140; Cooke, T. 2: 270 (2: 340); Santapau, 47: 657.

P. pubescens Wight, Ill. t. 166B, f. 6, 1850 (non Linn. 1753).

Rare weed in waste-lands along roadsides.

FLOWERS: July-August.

Solanum Linn.

1. Plants climbing ....*S. wendlandii*
1. Plants not climbing 2
   2. Plants armed with spines 3
      3. Herbs .... *S. melongena* (p.p.)
      3. Shrubs or undershrubs 4
         4. Leaves white tomentose on ventral surface ....*S. giganteum*
         4. Leaves glabrous............*S. indicum*
   2. Plants unarmed 5
      5. Shrubs .... *S. erianthum*
      5. Herbs 6
         6. Flowers in umbels, white.....*S. nigrum*
         6. Flowers in racemes, pale violet or mauve coloured..........*S. melongena* (p.p.)

1. **Solanum giganteum** Jacq., Coll. 4: 125, 1790; Graham, 138; Dalz. & Gibs. 175; Wight, Icon. t. 893; FBI 4: 233; Nairne, 208; Cooke, T. 649 & 2: 266 (2: 336); Talbot 2: 303; Santapau, 399, 1962 & 309, 1963.

Very common and abundant, often very gregarious, along roadsides, in forest clearings and in waste-lands.

FLOWERS: August-November.

LOCAL NAMES: Chuna Jhad, Kutri.

2. **Solanum indicum** Linn. Sp. Pl. 187, 1753 (pro parte); Graham, 138; Wight, Icon. t. 346; Dalz. & Gibs. 174; Lisboa, 218; FBI 4: 234; Birdwood, 19; Cooke, T. 649 & 2: 266 (2: 336); Santapau, 47: 653 & 309, 1963; Puri & Mahajan, 128.

Common, at times gregarious, among the undergrowth of the forests.

FLOWERS & FRUITS: June-February.

LOCAL NAMES: Chiturti, Ran-vangi.

3. **Solanum melongena** Linn., Sp. Pl. 186, Graham, 138; Dalz. & Gibs. suppl. 61; FBI 4: 235; Cooke, T. 2: 269 (2: 339); Santapau, 47: 655.

S. esculentum Dunal, Hist. Solanum 208, t. 3, 1813.

Cultivated for fruits which are used as a vegetable. Occasionally found in waste lands as an escape from cultivation.

FLOWERS & FRUITS: Throughout the year.

LOCAL NAME: Vangi.

4. **Solanum nigrum** Linn. Sp. Pl. 186, 1753; FBI 4: 229; Birdwood, 19; Nairne, 208; Cooke, T. 2: 263 (2: 332); Santapau, 47: 652; Puri & Mahajan, 128.

S. rubrum Mill., Gard. Dict. ed. 8, no. 4, 1768 (non Linn. 1767); Wight, Icon. t. 344, 1840.

S. incertum Dunal, Hist. Sol. 155, 1813; Graham, 137.

Common weed along road-sides, in gardens and moist wastelands.

FLOWERS & FRUITS: August-October.

LOCAL NAME: Ringni.

5. **Solanum erianthum** D. Don, Prodr. 96, 1825; Roe, in Taxon 17: 176, 1968.

S. verbascifolium Wight, Icon. t. 1398, 1848 (non Linn., 1753); Dalz. & Gibs. Bombay Fl. 175, 1861; FBI 4: 230; Cooke, T. 2: 263 (2: 333); Talbot 2: 302; Santapau, 47: 653 & 309, 1963.

S. pubescens Roxb. Fl. Ind. 2: 244, 1824 (non Willd., 1794). Willd., 1794).

Talbot has reported this species from laterites of Mahabaleshwar. Not seen by us.

6. **Solanum tuberosum** Linn.* Sp. Pl. 185, 1753; Graham, 137; Dalz. & Gibs. suppl. 60; FBI 4: 229; Lee, 646; Lisboa, 219; Cooke, T. 2: 269 (2: 339); Santapau 47: 655.

Lycopersicon tuberosum Mill. Gard. Dict. ed. 8, no. 7, 1768.

The Potato plant is extensively cultivated on all possible cultivable lands. Tubers are dispatched to Bombay and Poona markets on wholesale basis. According to Graham, the red soil of Mahabaleshwar suits well for this crop.

7. **Solanum wendlandii** Hook. f. in Curt. Bot. Mag. t. 6914, 1887; Bor & Raizada, Some Beautiful Indian Climb. & Shrubs, 125, 1954.

Large twining perennial cultivated in local gardens.

FLOWERS: June.

(To be continued)

* Cultivated.

BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS[1]

Part IX — *Hipposideros lankadiva* (Kelaart) — Hipposideridae

V. M. Sapkal and W. R. Bhandarkar[2]

Specimens of *Hipposideros lankadiva* (Kelaart) were collected from old temples and unused tunnels from Chandrapur about 160 kilometres from Nagpur. This large bat lives in colonies which vary from a scattered gathering of 50 to 100 individuals to thousands. The bat is very active and both males and females are found in the same colony throughout the year. It has an annual breeding cycle and each female delivers a single young one during each cycle. Deliveries in the colony occur from the 10th May to the end of May. There is a dominance of the left side of the genitalia over the right a few cases showing ovulation and pregnancy in the right. The gestation period is prolonged due to a retarded development of the embryo after implantation and is of about 260 days. Females are sexually quiescent only for a short period from 1st week of August to the middle of August. The young ones do not attain sexual maturity in the year of birth. The colony shows a female dominant sex-ratio.

Introduction

Although the family Hipposideridae is represented by several species in India, some aspects of the breeding biology of only a few species have been studied (Gopalakrishna and Moghe 1960; Gopalakrishna and Bhatia 1980; Gopalakrishna and Bhatia 1983).

The present paper on the breeding habits of *Hipposideros lankadiva* is a part of the overall programme of the study of reproductive biology of Indian bats undertaken in this laboratory. This species has been chosen for detailed study because it not only exhibits some unusual features but it also differs considerably from the breeding behaviour of a closely related species, *Hipposideros speoris* (Gopalakrishna and Bhatia 1983) inspite of living in the same geographical situation and under the same ecological conditions. In fact, *Hipposideros lankadiva* is often associated with *Hipposideros speoris* since the two species live in the same roost.

Material and Methods

Specimens of *Hipposideros lankadiva* were obtained from their natural roosting places at and near Chandrapur about 160 kilometres south of Nagpur. The specimens were collected from November 1976 to May 1979 such that every calendar month was represented by one collection or more. The specimens were netted at random during daytime and sometimes during the night. After recording the significant characteristics of the external genitalia in the males and the mammary nipples and pubic dugs in the females, the animals were killed by chloroform and their body weight recorded by a sensitive spring balance. The reproductive tracts were dissected out and fixed in Bouin's fixative or 10% formalin and were preserved in 70% alcohol. In the case of the males the right testis of each specimen was taken out of 70%

[1] Accepted May 1981.

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TABLE I

SUMMARY OF THE COLLECTION DIARY

Date of collection	MALES Immature Attached	MALES Immature Free	MALES Adult	MALES Total	FEMALES Immature Attached	FEMALES Immature Free	FEMALES Adult Non-pregnant	FEMALES Adult Pregnant Right horn	FEMALES Adult Pregnant Left horn	FEMALES Adult Lactating	FEMALES Total	Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12
2-1-79	–	–	2	2	–	2	–	–	4	–	6	8
5-1-78	–	–	–	–	–	–	–	–	2	–	2	2
14-1-79	–	1	2	3	–	1	–	–	2	–	3	6
5-2-79	–	–	2	2	–	1	–	–	4	–	5	7
19-2-78	–	1	–	1	–	–	1	–	10	–	11	12
23-2-78	–	1	2	3	–	2	–	1	4	–	7	10
28-2-78	–	–	3	3	–	1	–	1	4	–	6	9
9-3-79	–	–	2	2	–	2	–	1	4	–	7	9
18-3-78	–	–	1	1	–	2	–	2	9	–	13	14
25-3-79	–	–	2	2	–	–	–	–	4	–	4	6
2-4-77	–	–	3	3	–	–	–	–	–	–	–	3
9-4-78	–	–	–	–	–	–	–	–	4	–	4	4
10-4-77	–	1	3	4	–	3	–	2	9	–	14	18
16-4-79	–	–	4	4	–	2	–	–	3	–	5	9
22-4-78	–	–	2	2	–	2	–	1	4	–	7	9
1-5-78	–	–	5	5	–	–	–	–	2	–	2	7
10-5-79	1	–	2	3	–	2	–	–	3	1	6	9
13-5-77	–	–	6	6	–	–	–	–	–	–	–	6
14-5-77	1	–	–	1	–	3	–	1	4	1	9	10
24-5-78	1	1	–	2	2	1	–	–	1	3	7	9
6-6-77	4	1	–	5	1	2	1	–	–	11	15	20
13-6-78	1	–	7	8	–	1	1	–	–	6	8	16
21-6-78	1	–	–	1	–	1	–	–	–	2	3	4
25-6-77	–	2	6	8	–	–	–	–	–	–	–	8
26-6-77	1	3	3	7	–	5	3	–	–	6	14	21
1-7-78	–	1	9	10	–	–	3	–	–	–	3	13
9-7-78	–	1	3	4	–	–	1	–	–	2	3	7
16-7-77	–	–	4	4	–	1	2	–	–	–	3	7
20-7-78	–	1	4	5	–	–	3	–	–	3	6	11
30-7-77	–	1	5	6	–	6	3	–	–	2	11	17
3-8-77	–	–	3	3	–	1	4	–	–	–	5	8
12-8-78	–	2	2	4	–	3	5	–	–	2	10	14
21-8-77	–	2	5	7	–	–	–	–	–	–	–	7
24-8-78	–	–	5	5	–	4	3	–	3	–	10	15
5-9-78	–	–	2	2	–	4	3	1	12	–	20	22
10-9-77	–	3	6	9	–	1	–	–	2	–	3	12
10-9-78	–	–	2	2	–	2	–	–	8	–	10	12
14-9-78	–	–	2	2	–	–	–	–	1	–	1	3

TABLE I (Contd.)

	1	2	3	4	5	6	7	8	9	10	11	12
24-9-78	–	1	8	9	–	2	–	1	8	–	11	20
30-9-77	–	–	2	2	–	1	–	–	3	–	4	6
1-10-77	–	–	2	2	–	1	–	1	6	–	8	10
14-10-78	–	–	2	2	–	–	–	–	3	–	3	5
17-10-78	–	–	6	6	–	4	–	–	9	–	13	19
28-10-77	–	–	6	6	–	7	–	3	4	–	14	20
1-11-76	–	3	9	12	–	–	–	–	2	–	2	14
14-11-76	–	–	3	3	–	–	–	–	1	–	1	4
18-11-77	–	–	1	1	–	–	–	–	1	–	1	2
20-11-78	–	–	4	4	–	4	–	–	5	–	9	13
10-12-77	–	–	4	4	–	1	–	1	8	–	10	14
18-12-78	–	–	2	2	–	1	–	1	2	–	4	6

TABLE II

MONTHWISE COLLECTION OF SPECIMENS

Month	Immature attached	males free	Adult males	Total males	Immature Attached	females Free	Adult females	Total females	Grand total
January	–	1	4	5	–	3	8	11	16
February	–	2	7	9	–	4	25	29	38
March	–	–	5	5	–	4	20	24	29
April	–	1	12	13	–	7	23	30	43
May	3	1	13	17	2	6	16	24	41
June	7	6	16	29	1	9	30	40	69
July	–	4	25	29	–	7	19	26	55
August	–	4	15	19	–	8	17	25	44
September	–	4	22	26	–	10	39	49	75
October	–	–	16	16	–	12	26	38	54
November	–	3	17	20	–	4	9	13	33
December	–	–	6	6	–	2	12	14	20
	10	26	158	194	3	76	244	323	517

alcohol, gently rolled on filter paper and quickly weighed in a Mettler balance. This gave accurate relative weights of the testes of different specimens since all the testes of all the males were subjected to the same procedure. Table I gives the summary of the collection diary and Table II gives the monthwise collection of the specimens.

OBSERVATIONS

1. *General remarks*

Hipposideros lankadiva is a large bat as compared to other hipposiderid bats. The maximum weight of the male is 76 gms and that of the non-pregnant female 55 gms. The species shows a variety of fur colour. The

most common types are fulvous brown and reddish brown. Sometimes a greyish brown and bright golden red type of fur is also noticed. A golden colour of the fur is also noticed in some other bats of the family Hipposideridae-*Hipposideros caffer* in Africa and *Hipposideros calcaratus, Hipposideros cupidus* and *Hipposideros galeritus* in New Guinea (Brosset 1962, Menzies 1973). In all these cases the change of colour was attributed to high humidity, high temperature and high ammonia concentrations.

Hipposideros lankadiva lives in colonies in old temples and unused tunnels. This bat is very active and flies away on the slightest disturbance. The population in the different colonies varies from a scattered gathering of about 50 to 100 individuals to thousands. Brosset (1962) reported a colony of 5,000 to 7,000 specimens from Mandu, in Central India. In Chandrapur the largest colony was about 2,000 to 3,000 specimens clinging to the crevices in the wall of old temples and tunnels. The regular roosts are full of huge deposits of guano. Specimens of *Hipposideros lankadiva* are found together with *Hipposideros speoris* in some roost. Males and females are collected from the same roost throughout the year indicating that there is no segregation of sexes either on the basis of age or on the basis of sexual activity during any season of the year.

2. *Female genitalia*

The ovary ovoid in shape and is enclosed in a complete ovarian bursa. It is attached to the dorsal ligament by a narrow hilus. The Fallopian tube arises from the posteromedian aspect of the ovarian bursa, and, after taking a slightly tortuous curve around the cranial surface, bends caudally to open into the cranial end of the respective uterine cornu. The uterus is bicornuate and the two uterine cornua are morphologically symmetrical. Each uterine cornu of a non-pregnant adult specimen appears to bulge at its anterior end. The two cornua meet mesially forming a V-shaped structure. The uterine cornu measures 5 mm in length. The vagina is about 9 mm long and opens by a transverse slit-like opening.

A pair of pectoral mammary teats are present on the ventrolateral sides of the thorax and a pair of pubic dugs on the ospubis, one on either side of the midline. In the majority of the females, the right pubic teat is longer than the left, suggesting the probability of its being used more.

The young one clings to the ventral side of the mother's abdomen with the pubic dugs in its mouth. Thus the unweaned young one is found attached to the mother in the head to tail position during rest. Most of the young ones hold the right pubic teat and sometimes both in their mouth keeping the hind limbs free or forming a loose embrace around the neck of the mother. While sucking, the young holds the mammary nipples by the jaws, while the claws of the feet are firmly anchored to the pubic teats.

3. *Breeding habits*

Examination of the collection diary and Tables I and II reveals that *Hipposideros lankadiva* is a seasonally breeding species and exhibits several interesting features. Pregnancy as evidenced by the presence of a bulbous uterine cornu, was noticed from the first week of September to about the last week of May. Microscopic examination of the female reproductive organs revealed that the females collected on the 12th of August had not copulated and both the ovaries contained vesicular follicles only. However, out of the eight adult females collected on 24th August, four had pre-ovulatory follicles in the left ovary and sperms in their genital tracts, three had an early extrovert corpus luteum each in their

left ovary and an egg in the eight cell stage in the Fallopian tube thereby indicating that ovulation and fertilisation must have taken place a day or two earlier and one had multilaminar follicles with intercellular chinks in the left ovary.

Out of the 14 females collected on 5th September, one had an unfertilised egg surrounded by cumulus cells in the ovarian bursa and sperms in the uterine part of the Fallopian tube and uterus, three had pre-ovulatory follicles about to rupture and sperms in the genital tract and the remaining nine showed unquestionable pregnancy in the left uterine cornu. Some females collected on 9th and 10th September showed late stages of cleavage in the Fallopian tube with degenerate sperms in the uterine glands and those on 24th September had free blastocysts in the uterine lumen. Some females collected between 1st to 17th October showed various stages of implantation. From these facts it is evident that all the females in the colony copulate and conceive approximately between the 22nd August and 5th September.

The first delivered baby was collected on 10th May. The uterus of the mother had not involuted and the young one had a small umbilical stub, closed eyelids, was without hair and weighed 8 gms. Since the full term foetuses were of the same weight it is evident that this young bat must have been delivered a few hours earlier. During subsequent collections more and more females in the colony were found to have delivered their young ones. One pregnant female collected on 24th May had a full term foetus which, from its size, weight and development, would have delivered in a day or two. Pregnant females were not present in the colony after this date. The above facts indicate that all deliveries take place within a span of two weeks that is between second and last week of May.

The females carrying a young one at their breasts were collected from 10th May to 26th June. It cannot be ascertained if the young ones were incessantly carried by their mother during this period. The highest weight of the young at breast was 22 gm. The first batch of young were collected on 6th June and weighed 25 gm. Assuming that these young ones had been delivered in the 1st batch (10th May) and that they were carried by their mother till 6th June, it is evident that the mother carries the young for about 26 days. However, even after they leave their mothers they may be sucking the milk of the mother for some time more as evidenced by the fact that the mammary glands of the females continue to ooze milk on pressing till 12th August, and curdled milk was found in the stomach of several free young ones.

From the foregoing account of the breeding habits of *Hipposideros lankadiva,* the annual reproductive cycle of the female can be recognised into the following periods:

1. A short period of sexual quiescence from first week of August to about the middle of August.
2. Oestrus- copulation and fertilisation during the latter half of August and the first week of September.
3. Pregnancy- from about the latter half of August to first week of May.
4. Parturition- during the 10th and the end of May.
5. Lactation- from the second week of May to the first week of August.

4. *Duration of pregnancy*

The duration of pregnancy as is evidenced by the above data is of about 260 days allowing a margin of 4 to 5 days on either side — the date when the first delivery occurred (10th May) and the date when the egg in early cleavage was noticed (24th August). An inter-

esting feature of the pregnancy of this species is that the uterine bulb did not increase noticeably until the end of December. However, from January onwards the bulbs started increasing in size until parturition in May. These facts suggest that after implantation of the blastocyst the embryonic development is retarded for about four months until December, and is responsible for the unusually prolonged pregnancy of this bat. The factors responsible for this are not known.

5. *Number of young*

Examination of the collection diary reveals that out of 169 pregnant females collected, 152 carried the embryos in the left cornu and 17 in the right. Histological examination of the ovaries of these pregnant specimens revealed that the corpus luteum was invariably present in the ovaries ipsilateral to the uterine cornu carrying the conceptus. Evidently, transuterine migration of the embryo had not taken place in any specimen. Futher, there is no evidence to indicate that there is physiological alternation of the two sides of the genitalia. On the other hand there is a distinct unilateral physiological dominance of the left side of the female genitalia. Such a dominance of the left side is reported in other hipposiderid bats (Gopalakrishna and Moghe 1960, Gopalakrishna and Madhavan 1978, Madhavan *et al.* 1979, Gopalakrishna and Bhatia 1983).

6. *Growth and maturity*

It has already been mentioned that all the females deliver within a span of a fortnight (10th May to 24th May). The newly born young ones weigh about 9 gm when they leave the mother. The first batch of free young ones weighing 22 gm were collected on 6th June and young ones at breasts were collected up till 21st June. Milk was present in the mammary glands until 12 August. Examination of the stomach contents of juveniles weighing 25 to 30 gm revealed the presence of curdled milk in their stomach. It is evident that the young ones must be visiting the mother for sucking even after they become free. Evidently the young ones grow rapidly during the period when they suck milk and their body weight increases three times by the time they are weaned. These juveniles can be recognised by their darker fur colour. After 30th July it is not possible to recognise the juveniles from adults on the basis of fur colour and size of the body.

The mammary nipples and pubic dugs are inconspicuous in virgin females, but they increase in size during the first pregnancy and lactation and remain conspicuous throughout the rest of the life of parous females. Thus, the size and nature of the character of the mammary nipples and pubic dugs can be used as valid criteria to determine the sexual maturity or otherwise of the females.

The collection diary reveals that some females having inconspicuous mammary nipples and pubic dugs were present in the colony during the breeding and pregnancy periods. On histological examination they revealed a typical juvenile conditions of the ovaries and genitalia. Amongst the males also a number of immature specimens (immature as revealed by the size and histological characteristics of the testis and accessory sex organs) were collected during the breeding season. The occurrence of immature females and males during the breeding season indicates that sexual maturity is not attained in this species in the year of birth. It has already been noted that the first batch of delivered young were collected on 10th May and that copulation took place on 24th August. These facts indicate that the animals of either sex take atleast 16 to 17 months to attain sexual maturity. During the breeding season the female population shows three categories of individuals — i) im-

mature females, ii) nonparous females experiencing their first pregnancy and iii) parous females in their second or subsequent pregnancies.

7. *Sex-ratio*

Among 517 specimens netted at random at regular intervals for two years there were 323 females and 194 males. Since there is no segregation of sexes with regard to age or season, this should be the natural sex-ratio of this species. The number of sucking individuals in the collection was too small to give any indication about the sex-ratio at birth. But among 102 free immature specimens collected there were 76 females and 26 males (Table II). It is thus evident that there is a preferential mortality of the males during the growth period. This unbalanced sex-ratio during the immature period continues to the adult period giving an unbalanced female dominant sex-ratio in the colony. During the period of copulation and ovulation (last week of August and first week of September) also, the adult population is female dominant.

Amongst the hipposiderid bats a female dominant sex-ratio has been reported in *Hipposideros ater ater* (Gopalakrishna and Madhavan 1978), *Hipposideros fulvus fulvus* (Madhavan *et al.* 1979) and *Hipposideros speoris* (Gopalakrishna and Bhatia 1983). The present observations confirm the female dominant sex-ratio in this species and is at variance with the report by Abdulali (1949) for this species. Perhaps Abdulali (1949) based his conclusions on only a few isolated collections from only one or two colonies. Hence he probably missed the exact sex-ratio of this animal. This bat, therefore, conforms to the norms of sex-ratio noticed by most workers in most of the Indian and European bats in general and hipposiderid bats in particular.

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ACTIVITY PATTERNS IN A COLONY OF PEAFOWLS (*PAVO CRISTATUS*) IN NATURE[1]

K. Navaneethakannan[2]

(*With five text-figures*)

i) The activity patterns as regards the external environment of *Pavo cristatus* occupying an area at Nagamalai ridges near Madurai Kamaraj University campus and consisting of approximately 50 peafowls of either sexes were studied.
ii) Onset of activity of the first flyer from their roosting tree corresponds to the time of sunrise throughout the period of observation thus implicating the light as the chief synchronizing agent.
iii) Returning activity occurs around the time of sunset, and the phase relation (ψ end) is as precise as for emergence.
iv) Activity time is correlated with the duration of photoperiod Increase in photoperiod results in an increase in the duration of activity.
v) The value of light intensity and the movement of departure of the first flyer does not exhibit any systematic triggering light intensity threshold.

Introduction

Many field studies have been undertaken on birds and small mammals of temperate regions as regards their timings of activity in relation to environmental factors over the seasons (Voute *et al.* 1974, Daan and Aschoff 1975, Erkinaro 1972). Their activity rhythms are mainly regulated by light/darkness cycle of nature. Other extrinsic factors such as temperature (Hoffmann 1968), sound (Menaker and Eskin 1966, Gwinner 1966) and social cues (Marimuthu *et al.* 1981) and intrinsic factors such as hormones (Turek *et al.* 1976), can also eventually modify several such activity rhythms.

Daily beginning and end of activities, in day-active birds correspond to timings of sunrise and sunset respectively, and keep closer pace with them in temperate regions, (Daan and Aschoff 1975). Such systematic study, however, is not available for activity patterns of tropical birds. Day length varies only marginally in the regions closer to the equator. The day length, however, varies by about 1 h and 22 min over the seasons of the year at Madurai (lat. 9°58'N, long. 78°10'E). The present study describes the activity patterns of peafowls, *Pavo cristatus* and correlates them to environmental factors such as sunrise, sunset and photoperiod.

Terminology:

α — duration of activity
ψ — phase angle difference
ψ onset — Time interval between sunrise and onset of activity
ψ end — Time interval between sunset and end of activity
ψ midpoint — 1/2 (ψ onset + ψ end)

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HABITAT DESCRIPTION AND STUDY METHODS

The study area is located at the foothills of the Nagamalai ridge to the north of the Madurai Kamaraj University campus (lat. 9° 58′N, long. 78°10′E) and houses a colony of peafowl of *c.* 50. The ridge lies in the east-west axis and is approximately 10 km. the southern flank of which is a rain shadow. The habitat is surrounded by thick scrub jungle with rich bird and ground insect population. Water availability is scarce because of the rock surface of the habitat. Peafowls usually roost on the branches of *Acacia* spp. and on palmyra trees.

All day-watches were made from July 1980 until the end of March 1981 in that area. The observer was positioned away from these roosting sites and noise and movement were kept to a minimum. The time of beginning of activity of the peafowl was recorded from a distance using a pair of binoculars. Values of light intensity were measured using an AEG lux meter at the time of onset of flight activity of peafowls from the roosting tree. Recordings of ambient temperature, rainfall and wind speed were obtained from the meteorological station of the Department of Animal Behaviour, School of Biological Sciences, Madurai Kamaraj University. Sunrise, sunset data were obtained from the tables of 'Nautical Almanac'.

RESULTS

Pattern of emergence activity, based on the number of peafowls which fly from the roosting trees with time is typically a bell shaped curve as shown in Fig. 1. On the contrary the pattern of end of foraging activity (number of peafowls roosting vs time) indicates that the peak of roosting occurred *en masse.* (Fig 1)

The time of beginning of activity of birds from the roosting trees was related to the time of sunrise as shown in Fig. 2. The beginning of activity time varied between 0544 h (July) to 0640 h (March) during the period of investigations. This closely parallels the sunrise time

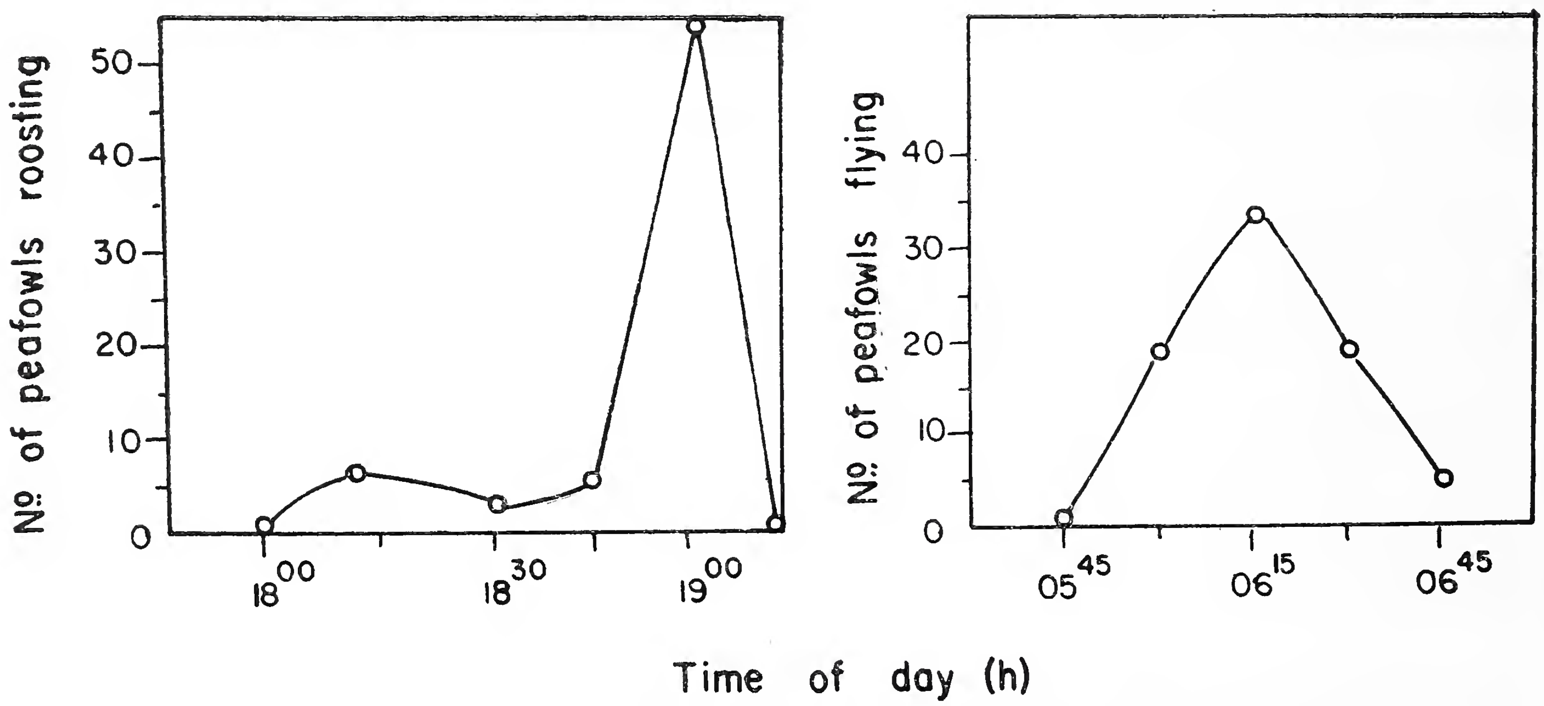

Fig. 1. Onset of foraging flight and end of activity are plotted as a function of time. The peak of onset of foraging activity is bell shaped. The roosting (end of activity) occurred *en masse* and vocalizations were frequent.

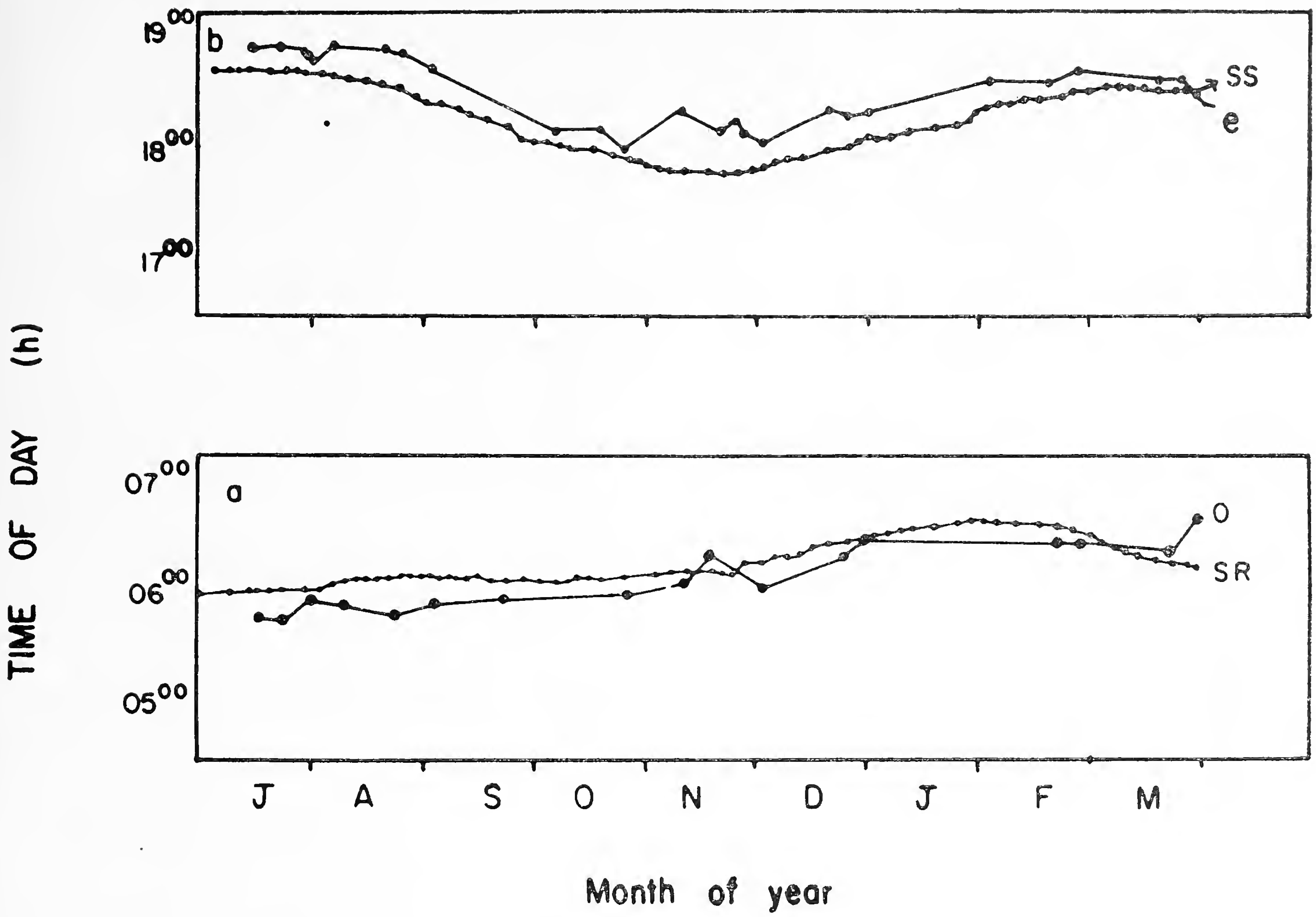

Fig. 2. (a) Field data on time of onset of activity of a colony of *Pavo cristatus*. Foraging flight from the roosting tree corresponds to the time of sunrise.
(b) The end of activity of the bird corresponds to the time of sunset.
Ordinate: Hour of day.
Abscissa: Month of year.

which varied between 0600 h and 0640 h. It is a common practice in circadian literature to relate the timings of onset and end of activity of diurnal animals to characteristic phase points of the daily sunrise and sunset. This phase angle difference, ψ onset, was calculated as the time difference between sunrise and the onset of activity (Fig. 3.)

Environmental variables other than light had a minor influence on the time of onset of activity. There was no evidence that the onset of activity was influenced by temperature since the mean temperature during the study period varied between 20°C and 37°C.

The peafowls vocalize while roosting. The birds started returning to the roosting site from 1700 h. The end of activity closely paralleled the time of sunset. For example, the time of end of activity varied between 1759 h and 1859 h over the study period which roughly paralleled the sunset time 18^{12} to 18^{42} h.

The phase angle difference ψ_e was calculated as the time difference between sunset and the end of activity of the last roosting bird. The ψ onset and ψ end values roughly mirror-image. (Fig. 3).

Activity time:

The analysis of activity time as a function of photoperiod (sunlight duration) shows that activity follows the seasonal variations in light dark ratio (Fig. 4). Activity time is positively correlated with the duration of the photoperiod. Increase in photoperiod resulted in an increased activity time.

Discussion

The day to day variations on the timings of onset of activity and end of activity may be considered to be indicative of the precision of the clock underlying and governing such activities. (Aschoff *et al.* 1972). The clock would be more precise if the onset of activity is nearer to sunrise: by the same token the end of activity to sunset in diurnal animals (Erkinaro 1972). In our study of birds there is seasonal variation in the onset of activity which ranges from 05^{44} to 06^{40} indicating a parallel seasonal shift with the time of sunrise from 0600 to 0640 h. Similar seasonal shift of end of activity is observed which keeps pace with the progression of the time of sunset. Aschoff and Wever (1962) have formulated that day to day variations in the time of activity onset are smaller

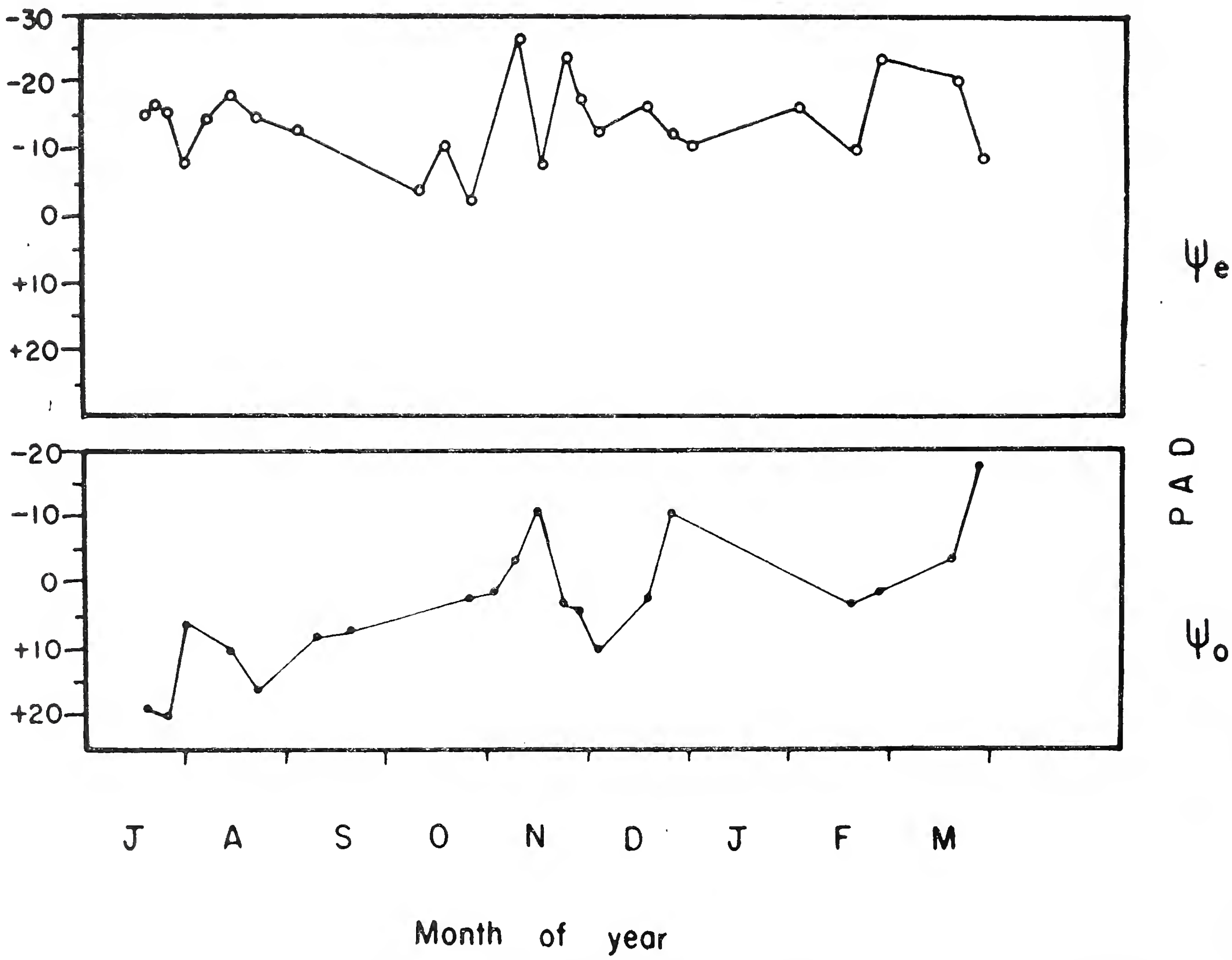

Fig. 3. Seasonal changes of onset and end in *Pavo cristatus*. The seasonal variations in ψ_o and ψ_e roughly mirror image.
Ordinate: ψ_o and ψ_e values in minutes.
Abscissa: Month of year.

than variations in the end of activity. Our peafowls exhibited no such day to day variations of onset relative to end of activity. Thus the data derived from the field study partly violates

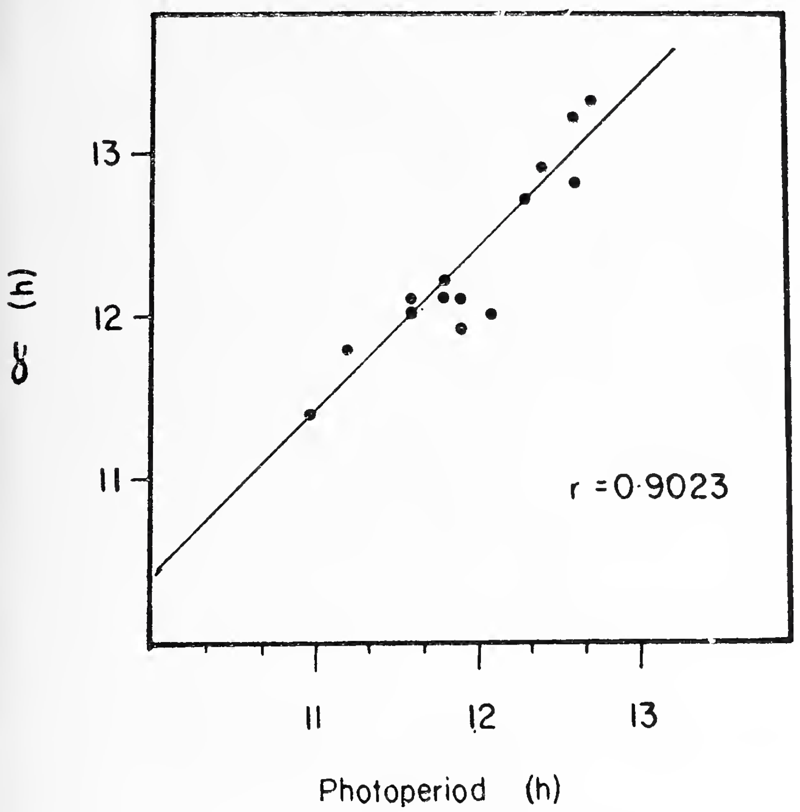

Fig. 4. Activity time is correlated with the duration of photoperiod. Activity time increases with increasing photoperiod.
Ordinate: Activity time (h).
Abscissa: Duration of photoperiod (h).

the Aschoff and Wever (1962) generalizations.

Activity onset in day active birds is usually at higher light intensities than end of activity (Daan and Aschoff 1975). The statement was based on the large number of studies compiled and supported by most of the analyses made by Daan and Aschoff in captive birds and mammals. In the present observations it was found that the peafowls begin and end their activity at similar light intensities. Such differences as are noted between temperate and tropical birds may be due to differences in the inherent sensitivity of the animals to light intensities, to differences in climatic conditions and differences incident upon latitudinal factors and in the physiological status of the animals related to general living conditions. According to Aschoff (1965) the best way to measure appropriate phase relation in diurnal animals is to compare the midpoint of activity with the midpoint of day light. In Fig. 5 the activity midpoint has been plotted against season: ψ midpoint decreases as the daylength becomes shorter and increases as it grows longer. This observation accords with the seasonal rule of Aschoff (1964) and Daan and Aschoff (1975) which can be claimed to account for many diurnal animals.

The graph giving the duration of daily activity versus the photoperiod can be described as S-shaped in all species studied so far both in nature and in captivity. In our study activity time of birds paralleled the duration of photoperiod.

Changes of α occurred (which lead to S-shaped curve) only in those seasons with photoperiod shorter than 5 h and longer than 18 h which do not occur in our study area. However, the duration of α is a linear function of photoperiod.

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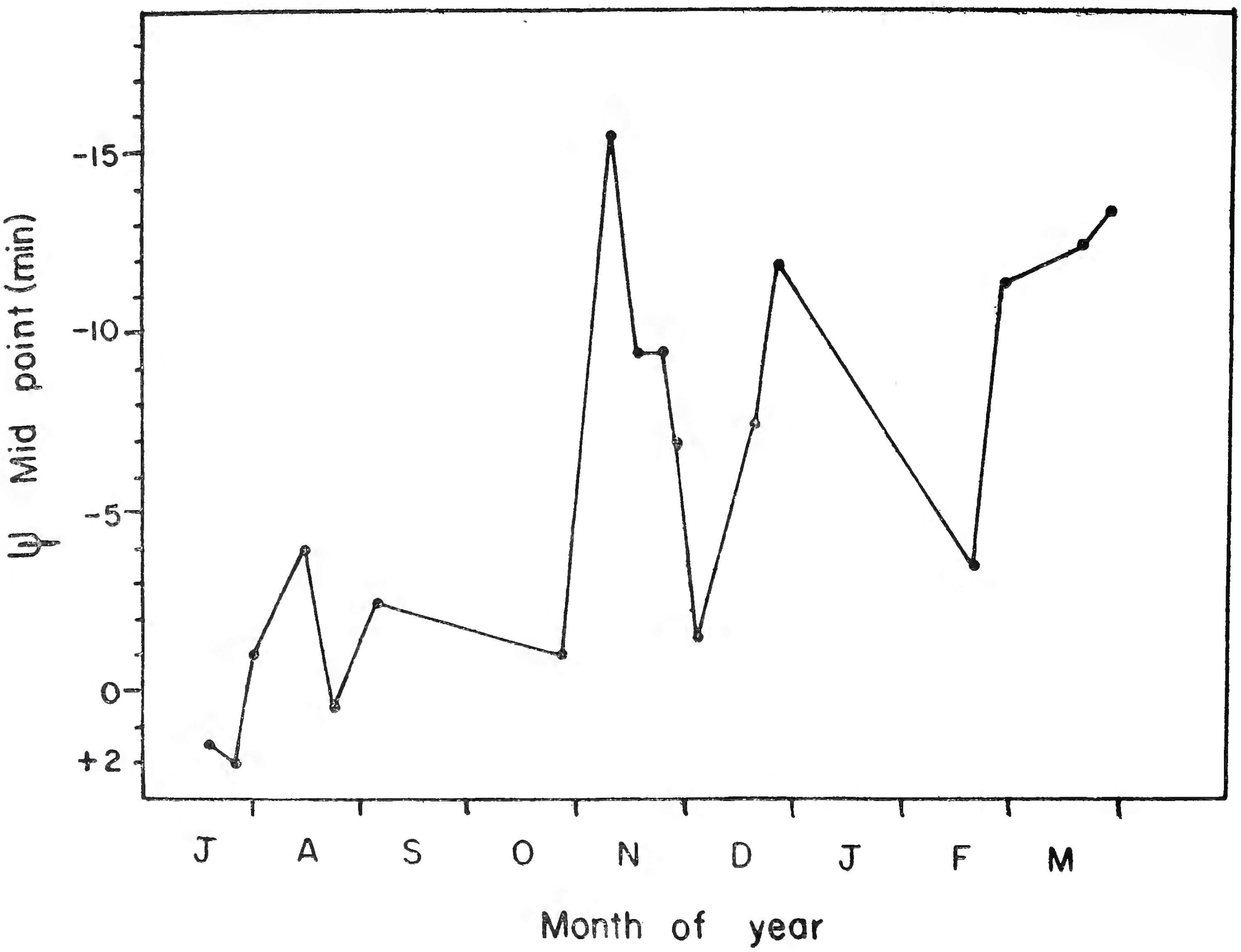

Fig. 5. Seasonal changes in the midpoint of activity (ψ midpoint). ψ midpoint decreases as the day length becomes shorter and increases as it grows longer
Ordinate: ψ midpoint in minutes.
Abscisca: Month of year.

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POPULATION STRUCTURE OF THE INDIAN HOUSE RAT, *RATTUS RATTUS RUFESCENS* IN THE INDIAN ARID ZONE[1]

RANJAN ADVANI AND B. D. RANA[2]

The Common house rat, *Rattus rattus rufescens* (Gray) were trapped from January 1980 to December 1980 by live Sherman traps from grain storages in Jodhpur (26°18'N —73°01'E). The females were found to be apparently heavier than males. On an annual basis, collection of females in pre-ponderance of males seems to be necessary to maintain higher densities of population in godowns. Subadult populations were recruited in greater proportion during all the months of year except January which is essential for faster regulation of a dense population of rodents.

A comparison of body weights, sex ratios and age structure of *R. rattus rufescens* has been made with available data of other Indian rodent species.

INTRODUCTION

Although intensive population studies have been carried out on field rodent species, little is known about the bionomics of the commensal rodents in the Indian desert. Constituting about 75 per cent of the total house rodent fauna, the Indian house rat, *Rattus rattus rufescens* is a well distributed species causing severe losses to the food grains in storage. Moreover, *Rattus rattus rufescens* litters throughout the year (Rana *et al.* 1982) and thus has attained a level of economic importance in the Indian desert (Cowan & Prakash 1978).

Keeping in view, the relative abundance, and economic status of this rat, studies have been undertaken at Central Arid Zone Research Institute, Jodhpur on ecology, biology and toxicology (Prakash *et al.* 1980, Advani *et al.* 1981, Rana *et al.* 1982). To make control operations more effective as well as meaningful and operation oriented, seasonal variations in body weights, sex ratios and age structure were studied in the Indian desert rodents, the results of which are reported and compared with those of the field rodents.

MATERIAL AND METHODS

The house rats (200♂♂, 242♀♀) were sampled from January 1980 to December 1980 with the help of live sherman traps from the grain *mandis* in and around Jodhpur (26°18'N —70°01'E). The Sherman traps were baited with peanut butter and were checked after every 6 hours, during which bait was replenished. After collection, the body weights of rats representing various age-groups and sexes were recorded on a spring balance (accuracy of 0.1 g). After killing the rodents with chloroform, they were sexed and grouped in two classes according to their body weights. Among males, those rats weighing under 80 g were considered to be subadults as they attain sexual maturity at about this body weight (Rana *et al.* 1982). Females having body

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weights lesser than 70 g were classified as subadults (absence of Corpora lutea and perforate vagina) while rest were considered as adult.

Results

Body weights

There were no statistical differences in seasonal variations in both the sexes of rodents. However, maximum body weights were recorded during May-June and November-December in males and during February-March and August-September in female rodents (Table 1). The males were found to be apparently heavier than the females during January, June, August, November and December. Whereas, the significant differences were noticed during May and June ($P< 0.05$, $P<0.01$) only. The females were heavier than males during February to April, July, September, October, with significant differences ($P<0.01$) only in September.

Table 1

Mean monthly body weights (g±S.E.) of *R. rattus*

Months	Body weights Male (1)	Female (2)	't' between 1 & 2
January	94.12± 9.52	89.73± 5.00	0.40
February	79.50± 9.39	93.94± 4.00	1.41
March	93.27± 7.71	95.20± 7.31	0.71
April	59.50± 7.00	77.44±11.16	1.36
May	109.90± 8.83	76.25± 3.05	3.60**
June	87.40± 8.92	66.65± 6.36	1.89*
July	65.09± 9.19	78.15± 5.76	1.20
August	95.85±10.00	87.15± 5.76	0.73
September	72.13± 7.01	104.00± 9.47	2.70**
October	77.47± 7.21	81.33± 5.67	0.42
November	83.57± 5.30	80.26± 3.49	0.65
December	90.44± 9.47	84.00± 6.50	0.53
Annual average	75.88±11.30	77.07± 9.18	0.081

* = $P<0.05$
** = $P<0.01$

Sex ratios

The preponderance of female *R. r. rufescens* were observed almost throughout the year except March, September to November. Interestingly, males constituted a very low proportion (range: 32.4 to 40.0 per cent) in the population during February, May to July (Table 2). On an average, the female population outnumbered significantly (x^2 (1) 3.98, $P<0.05$) in the total sample size collected.

Table 2

Monthly variations in the sex ratios of *R. rattus rufescens*

Months	Male	Female	% of males
January	16	24	40.0
February	12	18	40.0
March	23	20	53.4
April	16	18	47.0
May	15	22	40.5
June	15	23	39.4
July	12	25	32.4
August	20	24	45.4
September	21	18	53.7
October	19	17	52.6
November	18	17	51.5
December	13	16	44.8
Total	200	242	45.4

Age structure

Among males, preponderance of subadults (upto 80 g. body weight) was during April, July-October and thereafter, in December, indicating ideal months for weaning of newly born

TABLE 3

MONTHLY DISTRIBUTION OF WEIGHT CLASSES OF MALE AND FEMALE RATS EXPRESSED AS PER CENT OF MONTHLY COLLECTION

Weight classes (g)	Months of year											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						MALES						
20–50	25.0	25.0	17.3	56.2	33.3	13.3	41.6	30.0	42.9	15.8	27.8	30.8
51–80	6.2	25.0	30.4	12.5	6.6	33.3	41.7	3.0	42.9	52.7	27.8	30.7
81–110	37.5	25.0	26.0	25.0	26.6	20.0	—	2.0	4.8	21.0	33.3	23.1
111–140	18.8	16.6	21.7	6.2	26.6	33.3	16.7	1.5	9.4	5.2	—	7.7
141–170	12.5	8.3	—	—	6.6	—	—	5.0	—	5.2	—	7.7
171–200	—	—	4.3	—	—	—	—	—	—	—	—	—
						FEMALES						
20–50	12.5	16.6	15.0	27.7	31.8	39.1	4.0	25.0	22.2	11.9	11.7	25.0
51–80	20.8	11.1	20.0	16.6	50.0	30.4	56.0	29.1	16.6	41.1	53.0	43.7
81–110	58.3	33.3	30.0	27.7	18.2	17.4	16.0	29.2	22.3	29.4	35.3	25.0
111–140	14.2	27.7	30.0	22.2	—	13.0	24.0	12.5	30.3	—	—	—
141–170	14.2	11.1	5.0	5.5	—	—	—	4.2	—	17.6	—	6.3
171–200	—	—	—	—	—	—	—	—	5.6	—	—	—

young ones (Table 3). During April to August and then from October to December, the sub-adult females were recruited in natural populations in larger numbers. The body weight classes of 81-110 g and 111-140 g are more common in case of male rats, whereas, 111-140 g is not represented in all months of the year. However, weight classes of 140-170 g and 171-200 g have discontinuous and scattered distribution in the monthly collections of population.

DISCUSSION

As female *Rattus rattus rufescens* litters throughout the year, on an annual basis, females were found heavier than males, though the difference was insignificant. Occurrence of heavier females in September coincides with relatively higher (22.2%) prevalence of pregnancy (Rana *et al.* 1982) in this month. Likewise, their low fertility rate (13.0%) as well as lowest body weights (66.65±6.36 g) are recorded in June. In comparison to the Desert gerbil, *Meriones hurrianae* which shows considerable fluctuations in body weight structure (Prakash 1972), such seasonal variations are not found in case of *R. rattus rufescens*. It may be because of green nutritious food available to *M. hurrianae* population only during monsoon months, whereas, in godowns, *R. rattus* has sufficient supply of food to maintain its body weight more or less at a constant level. This concept holds true in another field rat species, *Rattus meltada pallidior*, due to its habit of selective feeding in nature (Rana & Advani 1981), and hence much variation in body weight is expected (Rana & Prakash 1982).

On an annual basis, females outnumbered (54.6%) the males (Table 2) supporting general sex ratio pattern among mammals inhabiting the Indian desert (Prakash 1974). However,

in the congeneric field rodents, *Rattus meltada pallidior* during a two year study, males always predominated the trapped population (Rana & Prakash 1982). The predominance of female *R. rattus rufescens* was observed even during the months of their peak prevalence of pregnancies in July and December. This is in contrast to the observations made by Raczynski (1964) who opined that during pregnancy females restrict their movements and therefore are trapped in lesser numbers than males. In case of present study, collections of rats were made from protected environments in godowns where food and space are sufficient for unchecked growth of any pest population. Therefore, both sexes were encountered in sufficient numbers. Moreover, to maintain a high density of population all the year round, preponderance of female sex in a population is essential. Likewise, in case of *R. meltada* infesting the irrigated crop fields which provide ample food to them round the year, male percentages were lower than those of females even during the months when prevalence of pregnancy was maximum (Rana & Prakash 1982). It appears that not only activity pattern or behaviour but also food and space influence the sex ratios obtained by trapping in a free living rodent population. On a yearly basis, male to female ratio was 1:1.21 which deviated significantly X^2 $(_1)$ = 3.98; $P<0.05$) from the 50:50 expected ratio. However, during March, September and November males were collected in larger numbers than females, whereas, insignificant differences between male and female numbers were found in other Indian rodent species like *Tatera indica cuvieri* (Prasad 1961); *T. indica indica* (Jain 1970), and *Rattus cutchicus cutchicus* (Prakash *et al.* 1973).

In pooled data for both the sexes of subadults it was revealed that except January, during all months subadults are encountered significantly in greater proportions. This may be due to faster regulation of population, higher annual productivity rate (Rana *et al.* 1982) and occurrence of pregnant females in all months during the year.

On the other hand, greater proportions of subadult males were collected in the latter half of the year (July-December) of *R. meltada pallidior* in western Rajasthan (Rana & Prakash 1982) and during first half of the year from the same species in South India (Chandrahas & Krishnaswami 1974). The regular recruitment of subadult rats in the population may be due to continuous food supply and shelter available to house-rats in grain *mandis*. Secondly, higher rate of prevalence of pregnancy in a confined population, is also one of the main regulating factors.

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RECENT ORNITHOLOGICAL RECORDS FROM PAKISTAN[1]

T. J. ROBERTS[2]

One of the biggest problems for any keen bird watcher in Pakistan today is that of trying to determine the real status of less common birds because of the lack of recent records or reliable observations and ones reliance perforce on very old and sometimes doubtful records.

It is with this aspect particularly in mind, that this note is written, based as it is on my diary notes from the past two or three years which add new information to the records which the Society was kind enough to publish in a note I submitted three years ago (Roberts 1981). I have included some recent findings of several ornithologist friends in order to give as complete a coverage as possible.

Oceanites oceanicus

Wilson's Storm Petrel is described in Vol. 2 of the HANDBOOK series (Salim Ali 1968) to be not uncommon along the coasts of Sind and Mekran (Pakistan's seaboard), from May/June onwards till about September/November when birds returning to their Antarctic breeding grounds are sighted off the coast of Sri Lanka.

Of all the Antarctic breeding sea birds, the majority nest on isolated southern latitude islands and only three or four species (2 Penguins, 1 Sheathbill and 1 Wilson's Storm Petrel) largely confine their nesting activity to the main Antarctic continental land mass. This little Petrel is reported to nest on high mountain crags further inland and under more extreme weather conditions than almost any other bird. This, coupled with its dainty appearance and "wave walking" habit, make it a particularly fascinating bird.

Along the Karachi seacoast it is not difficult to see this Petrel from certain promontories along the shore during the summer months. In the past two years with the help of a very experienced ornithologist friend, Rolf Passburg, we have been periodically surveying pelagic birds, by means of boat trips, during the winter months, and found to our surprise that considerable numbers of Wilson's Petrels feed along the coast throughout November, December and January (up to 15 and 22 birds sighted during a six hour voyage). Circumstances have prevented us from making surveys in February and early March but from late March and early April, Wilson's Storm Petrel can again be sighted, and it could be fairly assumed that a number of non-breeding birds remain during the Antarctic "summer" around the Arabian Sea and coastline of Pakistan.

Nettapus coromandelianus

The Pygmy Cotton Teal, it might be supposed, is largely a summer visitor to Pakistan like other endemic ducks such as the Spotbill (*Anas poecilorhyncha*) and Lesser Whistling Teal (*Dendrocygna javanica*). Volume I of the handbook describes it as rare or absent in

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the arid portions of Pakistan (Salim Ali 1968, page 191). Kenneth Eates who compiled the section of the Sind Gazetteer covering birds and mammals in the early 1950's (Sorley Edit., 1968), and who enthusiastically studied the Sind avifauna over more than thirty years service in that Province, described the Cotton Teal as very rare and only to be encountered in one or two swampy bush-studded "dhands" near Sujjawal in Thatta District. It would be fair to state that this little Pygmy Goose is on the increase in Pakistan, and that a considerable population is resident. For example on Hadeiro Lake some fifty-five miles northeast of Karachi, about 150 Cotton Teal can be seen throughout the winter and early summer months though there is some breeding dispersal during the monsoon. In the northern Punjab, near Kalabagh town in Mianwali District, I was surprised to encounter a group of ten Cotton Teal on January 23rd, 1981 in a seepage swamp upstream of the Islam Barrage on the Indus River, and this little group might well be resident also. There have also been frequent recent sightings from the Punjab Salt Range lakes.

Aythya marila

The Scaup Duck could be confused with other Pochards in winter or female plumage and it is known to be a rare duck on the subcontinent. Neither Brigadier Christison nor Dr. Ticehurst could find any records of this duck having been shot on passage in Baluchistan (Christison 1942, Ticehurst 1926-27). Similarly in writing about the birds of Sind, Ticehurst (1922) cast doubts on the reliability of J. A. Murrey's earlier records from Karachi (FAUNA OF BRITISH INDIA, Vol. IV page 462). Murray was curator of the museum at Karachi and a good all round vertebrate zoologist but not particularly experienced as an ornithologist. On March 27th, 1982 when most palearctic ducks had migrated north from lower Sind, Rolf Passburg and myself watched for some time through a telescope a female Scaup on Haleji Lake which is about 45 miles northeast of Karachi. It was feeding and very reluctant to fly even when we tried to put it up. A few Scaup must winter in the Arabian Sea and overfly Pakistan on migration and thus escape attention.

Stercorarius pomarinus

The Pomarine Skua is a distinctly heavier and larger bird than the Arctic Skua with broader vertical cross barring on its rear flanks. Its central tail feathers are spatulate not pointed as in the Arctic Skua. Passburg and myself now have several sightings of this Skua off Karachi coastal waters. On January 8th, 1982 a pair hunting cooperatively (klepto parasitising) Sandwich Terns (*Sterna sandvicensis*). April 2nd, 1982 another pair observed closely from Cape Monze from the shore. January 4th, 1983 two single birds resting on the sea at the mouth of Ghizri Creek. On all occasions we found this Skua fearless of motor launches and tolerant of very close approach (this contrasts with Humes' experience with Arctic Skuas). Arctic Skuas (*Stercorarius parasiticus*) are less unusual along Karachi sea coast. For example 12 were noted on March 14th, 1982, but we now believe that the Pomarine has been overlooked possibly because of a lack of reliable off-shore observations. The HANDBOOK records only a single authentic sighting off the coast of Sri Lanka in 1912 (Waite 1931).

Apus pacificus

The Himalayan White Rumped Swift is recorded in Volume IV (page 49) of the HANDBOOK as "certainly breeding in the Murree Hills". The only written record is of a small

colony of this Swift discovered in July 13th, 1907 by Major H. A. F. Magrath at Changla Gali in the Galis. He could hear the young calling inside rock clefts. This record was not published by Magrath himself in his records of the Murree Hills and Galis (Magrath 1909) but cited by Whistler in his notes on the 'Birds of Rawalpindi District' (Whistler 1930). It is significant that Colonel Rattray who worked this region very thoroughly in 1903-1904 did not record this Swift (See below under 'Golden Bush Robin'). Swifts are notoriously difficult to identify under conditions of bright sunlight and when feeding, as they normally do, high up in the sky. Since purchasing a summer cottage in the Galis in 1960, I have always been on the lookout for this Swift and failed to find it, particularly during searches around Changla Gali. It seems fair to conclude that they no longer breed in the Murree Hills. However for the first time, on May 16th, 1982 after an unusually late and stormy spring in the Murree Hills region I encountered a flock of about 30 White Rumped Swifts hawking around the summit of Mukhshpuri Mountain. They were accompanied by about 5 House Swifts (*Apus affinis*) and about 15 Common Swifts (*Apus apus*) which greatly facilitated comparison and identification. Mukhshpuri peak is only 9,300 feet high and my cottage stands on its lower slopes so I cannot recall the many scores of times that I have been on its summit. I never saw this Swift after May 16th, despite remaining in the area.

Recent studies of the Common Swift (*Apus apus*) (Bromhall 1980) have revealed the enormous distances that these masters of the air will travel in one day to find suitable feeding space. Twenty-five to thirty miles daily traversal from one point to another being not unusual, so this Mukhshpuri sighting cannot be taken as clear evidence of breeding within Pakistan and for me its status still remains enigmatic. *Apus apus* breeds throughout the drier Himalayan ranges of Pakistan but not in the Murree Hills. However occasional small groups of this species regularly visit the skies above the Murree Hill range.

Ceryle lugubris

The Greater Pied Kingfisher was once seen (Jan. 8th, 1926) by Hugh Whistler in the Leh Nullah just on the outskirts of Rawalpindi (Whistler, op. cit.) This nullah is now a foetid sewer and devoid of any Kingfisher species. Bates and Lowther in describing the breeding birds of Kashmir only encountered it on the Kishenjanga River in the extreme west (Bates & Lowther 1952). It still occurs today in Kashmir on the Kishenjanga now known as the Neelum River. Volume IV of the HANDBOOK records that it sometimes extends down to adjacent plains areas. In Islamabad, David Corfield has been indefatigable in collecting bird records over the past two years and he discovered a fine male specimen on a small feeder stream (Saidpur Nullah) draining into the newly created reservoir, Rawal Lake just on the outskirts of Islamabad. This was in February 1982. Subsequently a pair were seem by him on May 30th and again on September 29th, 1982 in the same locality. On January 4th, 1983 he kindly showed me both the male and female. The latter was distinctly maroon speckled in the pectoral region, whereas the male was marked with bolder black spots and both were haunting the same tiny stream within half a mile of the lake which lies at an elevation of about 1,000 feet. It seems possible that these birds actually nested last summer and obviously a keen watch will be maintained this year.

Picus chlorolophus

The Small Yellow-naped Woodpecker is re-

corded in Volume IV of the HANDBOOK as occurring in the Himalayas from Dharmsala eastwards through Himachal Pradesh but Pakistan is not mentioned and it was not observed by Whistler or H. Waite, both of whom collected extensively in the Murree Hills. Whistler rejects Captain Marshall's record of this species nesting in the Murree Hills (Whistler, op. cit.). On June 4th, 1982 whilst exploring the lower reaches of Kao Forest which clothes a valley draining northwards from Dunga Gali into the River Jhelum. I was very thrilled to encounter this Woodpecker. It was feeding in a fine stand of *Quercus incana* trees at about 6,500 feet elevation. Lower down the Kao Valley the slopes are bare of trees and terraced for cultivation until the banks of the Jhelum are reached but it seems probable that this rare straggler to the region must have wandered up the Jhelum River.

Pericrocotus roseus

Like the Himalayan White Rumped Swift, the Rosy Minivet had escaped me until last summer. There are skins in the British Museum at Tring from the Siran Nullah, in Mansehra Tehsil of Hazara District collected in 1870 by Unwin, but there were no sightings from the Murree Hills until H. Waite saw this species on May 24th, 1930 at the Forest Rest House in Ghora Gali around 6,000 feet elevation but was unable to collect a specimen (Waite, H. W., Ibis, 1930, page 37). This spot is on the outer or western flanks of the Murree Hills. In May and June 1982 I made several exploratory visits to a remote valley known as Manga which drains this same western slope and which is only accessible by Jeep track. Here on every occasion I encountered one or two Rosy Minivets and enjoyed close views of both sexes. Their contact calls, loud and carrying, as in most minivets are quite distinctive, comprising a rather rapid flutey piping. All available records show a rather local and disjunct distribution for this Minivet throughout the Himalayas. Its preferred habitat seems to be *Pinus roxburghi* with a dense thorny understory of *Cotoneaster* and *Zizyphus mauritiana.*

Sturnus malabaricus

The Grey headed Myna has not been recorded in Pakistan or indeed northwest of Mount Abu in Rajasthan. A party of three birds were watched on January 14th, 1983 feeding on the nectar of *Salmalia malabaricum* flowers. This was along a roadside plantation inside Gharko Forest, a small patch of riverain forest alongside the Indus River in Thatta District of lower Sind. In this region juvenile Rosy Pastors could easily be confused for the Grey Headed Myna as they are the typical Starlings of the area in winter, but I was attracted to these birds by their rufous chestnut throats and bellies. *Sturnus roseus* has a grey-brown breast. Closer examination showed their milky white irides and the leaden blue basal half of their yellow tipped bills as further distinct features. A juvenile *Sturnus roseus* has brown irides and horn coloured bill turning to yellowish at the base. Perhaps a few birds have regularly been wandering in winter into lower Sind and have escaped notice.

Sturnus contra

The Indian Pied Myna is quite an aggressively erruptive species and has for example spread into the Konkan region of Maharashtra State within the past twenty years (Humayun Abdulali, pers. comm.). I myself saw numbers on the outskirts of Borivli. It occurs in Delhi and Ludhiana of the Punjab but had not so far been recorded within Pakistan (HANDBOOK,

Volume 5, page 173). Mr. Z. B. Mirza, the Curator of Islamabad's new Museum of Natural History discovered a colony of about four pairs in Changa Manga irrigated forest plantation in March 1982 and collected a specimen. This locality is some fifteen miles west of Kasur on the main Karachi to Lahore railway line. I searched without success in the same locality later in May 1982 whilst Mr. Mirza, meanwhile in April, had located another colony at Jallo where there is a forest plantation some 2 miles north-east of Lahore city and not far from the Indian border. Mirza has since sighted two Pied Mynas in Sheikhpura District west of Lahore and it appears that this Myna is extending its range westwards.

Megalurus palustris

The Striated Marsh Warbler was never observed along the Chenab River by Whistler who wrote about the birds of Jhang District (Whistler 1922). Volume 8 (page 97) of the HANDBOOK records it as breeding from Pakistan in the Punjab, east through northern India, but the distribution map on page 97 seems to show that it does not extend as far as the Ravi River and hardly enters Pakistan. I cannot trace any published records of its occurrence within what is now Pakistan, nor had I been able to encounter this species until March 29th, 1981 when exploring the marshes and seepage zone upstream of Balloki Barrage on the Ravi River, forty miles downstream from Lahore. I found a pair frequenting rather open *Juncus* sedge and the male was giving it's loud and vehement display or song flight. If it had not been for this song I would certainly have mistaken it for a Striated Babbler (*Turdoides earlei*), which it resembles in size and plumage. The late Roger Holmes, with Z. B. Mirza, worked the Balloki Headworks and seepage areas fairly thoroughly in 1968/69 including visits during the monsoon and they never recorded this bird at that time, so it must be considered as a rare and irregular visitor to Pakistan.

Tarsiger chrysaeus

The Golden Bush Robin is listed in Volume 8 (page 234) of the HANDBOOK as occurring from Hazara eastwards and including the Murree Hills. This is presumably on the basis of Colonel Rattrays account of Bird Nesting in the Murree Hills and Galis". He considered it very rare but located one pair and took the nest, near Murree (presumably in Punjab not Hazara) (Rattray 1904). I have had a lot of trouble with Rattray's records in that a number of birds which he claimed to have collected the eggs of, are never seen in the Murree Hills nowadays, whilst one or two examples can be proved to be mistaken identification. He used a number of local hill men as collectors and does not seem to have preserved any skins though he frequently claimed in his writings to have shot the female off the nest for identification.

Hugh Whistler also recorded finding a nest which he thought was of this species, but it was robbed before he could confirm his identification (Whistler 1930). Again over twenty years I have always hoped to encounter it in the Murree Hills. In 1980 I made a rare October visit to Dunga Gali and with two friends found a female Golden Bush Robin on October 16th alongside a stream in the Haro Valley (which drains southwards to the Peshawar Vale) at about 6,500 feet elevation. It was watched for over an hour making sallies after insects. In flight the golden yellow webs of the outer tail feathers were conspicuous as well as the broad golden eye-brow stripe and a tiny golden spot behind the ear covets. It seemed rather furtive when not actually for-

aging and generally concealed itself inside a bush. Whether they actually breed in the Murree Hills remains to be substantiated by summer sightings but I have not come across any records after 1926.

Muscicapa rubeculoides

In my previous published note (Roberts 1981) I recorded the first discovery in Pakistan of a singing male Blue Throated Flycatcher on May 26th, 1979 in the Margalla Hills just west of Islamabad city. The following year in May, David Corfield found another male singing in an adjacent ravine some three miles north of my sighting. In 1982 we found one or two singing males in each of the three side ravines in the Margalla Hills, and on June 9th, 1982 I found them in the Manga Valley 15 miles northeast of Islamabad. This flycatcher is therefore, plainly a regular summer visitor to the Murree foothill zone. I never saw it above 3,000 feet elevation. It prefers the damper ravines having streams and a mixture of subtropical dry deciduous broad-leaved trees of Indo-Malaysian affinities. Because of its extremely skulking habits even when singing, it is very difficult to see and these records are a perfect example of the way in which an unusual or new bird suddenly seems to be widespread, once its call notes and song have become familiar to the observer.

Terpsiphone paradisi

The Paradise Flycatcher is described as a winter visitor to lower Sind (page 217, Volume 7, HANDBOOK) but the distribution map shows the main wintering population to be confined to Maharashtra and peninsular India. Based on records of Dr. Ticehurst and Kennth Eates (op. cit.) it is obviously extremely uncommon even on passage in Sind. Ticehurst collected one on October 23rd, 1918, the only one he ever saw, and J. A. Murray obtained a specimen on December 13th, 1877. For the past nine years that I have been living in Karachi I have noticed that the few remaining patches of riverain forest in Thatta District are the stronghold of this flycatcher both in spring and autumn passage but last year I realised that one or two individuals remained in Gharko Forest (see record above of Grey Headed Myna) throughout the winter. Again this year I have seen at least one female Paradise Flycatcher (probably the same individual, always located by its call) in every month, from early October to February 1st on visits to Gharko, and it can fairly be assumed to be a winter visitor. In fact this winter I also have a resident female Paradise Flycatcher in my garden at Malir and this is my first record of even a transient example of this species for this garden. Exactly the same remarks apply to sightings of the Grey Headed Flycatcher (*Culicicapa ceylonensis*), which I noted for the first time in mid January 1983 in Gharko Forest as well as one winter resident male (he sings territorially every morning) in our Malir garden. Perhaps this extension of wintering grounds into lower Sind for both these two flycatchers may be connected with the recent drought in the Thar Desert and parts of the Rann of Kutch region.

Tichodroma muraria

Not much has been recorded about the breeding of the Wall Creeper from any part of the Himalayan regions. The HANDBOOK mentions the sighting in July of newly fledged nestlings by Meinertzhagen in Ladakh at 6,400 metres. As my high altitude days are definitely over, I was really delighted to discover a Wall Creeper's nest at a comparatively low elevation on June 15th 1982 in the Kaghan Valley of Hazara District. The location was six miles

north of Burawai, at the bottom of the main valley on a sheer one hundred foot high earth and boulder cliff overlooking the river. The exact location is known as Tarli Seri as it is a popular camp for Gujar shepherds. I estimated the altitude at about 11,400 feet. The location was typical alpine habitat and I could only just make out the nest-hole entrance by crawling perilously out onto a ledge, but from a safer vantage point I could watch the parent birds arriving to feed their young. They appeared to be carrying beakfulls of insects with small moths and "lace wing" type flies. The female was browner and darker on the crown, the male noticeably white on the crown with darker and more contrasting plumage. Both birds on one occasion flew from the nest-hole with a faecal sack in their bill, so that parental care by both sexes and nest hygiene can be confirmed though I have not actually been able to see this recorded in any of the reference books which I have been able to consult. Neither parent bird flew direct into the nest (a hole between a boulder and the eroded earth cliff face). They settled on a projecting rock slab leading up to the nest-hole thus giving some opportunity to examine through binoculars the quantity of insects in their long rapier-like bills. They hopped across the rock face with typical wing flicking motions as though they were still compulsively searching for insects even when their intention was clearly to enter the nest-hole. Hodgsons Mountain Finches (*Leucosticte nemoricola*) were all around and sometimes settled on the boulder protruding below the Wall Creeper's nest. The female ignored them but I saw the male aggressively chase one away before returning to feed its young.

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A REPORT ON A COLLECTION OF AMPHIBIANS AND REPTILES FROM THE PONMUDI, KERALA, SOUTH INDIA[1]

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(*With three plates*)

Introduction

Knowledge of the herpetofauna of southwestern India has developed over the last 130 years through the efforts of many persons, generally as a result of accumulation of small collections from scattered localities. From the volume by Boulenger (1890) on amphibians and reptiles, the two volumes by Smith (1935, 1943) on lizards and snakes, and the numerous papers of N. Annandale, J. C. Daniel, R. S. Pillai, and C. R. N. Rao on amphibians, one can piece together a picture of the species diversity of the herpeto-fauna of this humid region of the subcontinent. However, until very recently, there has been no basis for estimating local diversity, because specific localities, as opposed to district place names, have not always been given. The first collection likely to provide an estimate of local diversity is that recently made at Silent Valley, Kerala, by Dr. R. S. Pillai of the Zoological Survey of India. We report here on a second, large local sample, this one from Ponmudi in southern Kerala, about 250 km south of Silent Valley and about 170 km south of the Anamallai Hills. This sample, collected May 3-June 17, 1982, was obtained as part of a joint project of the National Museum of Natural History, New Delhi (NMNHI) and the Field Museum of Natural History, Chicago (FMNH). The material is now housed in both institutions.

The area in which this collection was made centered on the Ponmudi ridge (8°45′N, 77°8′ E) and its slopes, from about 100 m above sea level to its crest at 1095 m. The extent of the area actually searched is difficult to determine, but we estimate that no site was more than 10 km (in a direct line) from the crest of the Ponmudi ridge and most were less than 5 km. The forest is now broken into large blocks of varying sizes, the largest in which we worked being 4-8 km wide. Intervening cleared areas are mainly large tea plantations. The dominant types of forests are designated by the Forestry Department, State of Kerala as tropical evergreen, moist deciduous, and, at the highest elevations only, low tropical evergreen (Adriel 1966). Most of our sampling was carried out in the first type, which has the typical 3-storied structure of tropical evergreen forest and an abundance of lianas, at elevations between 310 and 370 m. Rainfall is heavy (annual mean at Ponmudi 4603 mm) and seasonal. Between 1952-1961, only three months—January, February, and March-averaged less than 100 mm of rain. As the topographic relief is steep, the streams have beds of sand, gravel, and rock and moderate

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to strong current. Pools alternate with riffles and, in many places, low waterfalls. Most of the streams flow throughout the year. Those along which we sampled varied from 0.5 to 4 m in width.

Materials and Methods

Specimens were obtained by a party of 4-10 men collecting along streams and through patches of forest during daylight and early night hours. Rocks were turned, dead leaves scraped, and logs rolled and their bark stripped. Shrubs and trees were examined as high as the dim light and obscuring branches permitted. In addition, we used two procedures to guarantee close inspection of large areas of forest floor: (1) examination and removal of litter from buttress-enclosed areas at the bases of large trees, and (2) search of forest floor quadrats (see description of latter method in Lloyd *et al.* 1968). Although we include all specimens in this report, those obtained by the last two methods will be subject to special analysis in a subsequent publication.

As each specimen was captured, we placed it in a separate plastic bag and recorded its position when first sighted in terms of a complex microhabitat classification. We used the system described in Inger and Colwell (1977), expanded slightly to include all vegetation types encountered at Ponmudi. Upon return to the field laboratory, animals were anaesthetized, preserved in formalin, and each (with few exceptions) tagged with a separate number within three hours of capture. We maintained a few lizard eggs in plastic bags until hatching and kept some frog eggs until larvae reached early developmental stages.

In the text we give snout-vent lengths (SV) of adults, standard scale counts where appropriate, and body proportions relative to SV. For each species of frog, the smallest female having convoluted oviducts or developing ova sets the minimum size for maturity for females of that species; the smallest male having developed secondary sex characters serves the same purpose for males. Frog larvae are staged according to the scheme developed by Gosner (1960). Denticle formulae for larvae are presented in the standard form of using Roman numerals for undivided rows and Arabic numerals for divided ones. A slash separates the counts for upper and lower lips.

Elevations above sea level in metres (m) were determined with a Thommen pocket altimeter and are accurate to approximately 30 m.

Gegeneophis carnosus (Beddome)

Epicrium carnosum Beddome, 1870 Madras Month. J. Med. Sci., 2 : 176 — Periah Peak, Wynad.

Gegeneophis carnosus Boulenger, 1882, Cat. Batr. Grad. Brit. Mus., p. 101, pl. 8, fig. 3.

Material. A single specimen: total length 260 mm, width 7.5 mm, primary folds 120, secondary folds 6.

This specimen is uniform gray above and tannish-gray on the sides and vent. Anus transverse, tail absent; eye completely hidden.

Gegeneophis is similar to *Indotyphlus.* For our material, Taylor's (1961) key is not helpful since the position of the tentacle relative to the eye and nostril cannot be determined. Our specimen agrees well with Taylor's (1961) description in body proportions (width into length 35), color, and fold counts, all of which distinguish it from other *Gegeneophis.*

Ecological Notes. Our specimen was collected beneath a 25 cm rock along the bank of a 0.5 m wide stream in evergreen forest at 350 m elevation. Five eggs were found with the specimen. Daniel (1963) notes that individuals have been collected previously in the Ponmudi hills; specimens with eggs were reported by Seshachar (1942) from Tenmalai.

Ichthyophis beddomei Peters

Ichthyophis beddomei Peters, 1879, Monatsb. Akad. Wiss., Berlin, 1879: 932, fig. 4 — Nilgiri Hills.

Material. A single specimen : total length 190 mm, width 9.5 mm, body folds 304.

Dark brown above, light brown below, with a light yellow lateral stripe along each side. The stripe extends onto the head as far as the angle of the mouth, and is somewhat expanded dorsoventrally in the cheek region. The eye is clearly visible, and the tentacle is along the upper lip margin and about equidistant between the eye and nostril.

Our material agrees well with Taylor's (1961) diagnosis other than its slightly high fold count; Taylor lists 240-293 for 16 individuals.

Ecological Notes. This specimen was caught under a rock at the base of a tree in evergreen forest at 560 m above sea level.

Bufo beddomi Günther

Bufo beddomii Günther, 1875, Proc. Zool. Soc. London, 1875: 569 — Malabar.

Material. 3 adult females 36.8-45.1 mm SV, mean 40.2; 1 male 31.1 mm; 10 juveniles, 11.0-17.2 mm. Tibia 0.40-0.45 of SV in females, 0.48 in male.

Above uniform dark brown; a faint black barring pattern on the hind legs and feet. Beneath tan, with an irregular marbling of dark brown. In life, the dorsal surfaces of the feet reddish-brown, contrasting sharply with the dorsal color.

Immature individuals may be difficult to distinguish from sympatric *B. parietalis* since both lack bony ridges on the head. However, even the smallest *B. beddomi* (11 mm SV) are densely covered with sharp, conical warts on the dorsum, head, and eyelids, and have warty paratoids with uneven indented margins. Young *B. parietalis* have extremely fine spicules on the head and eyelids, grading into larger, thinly dispersed warts on the paratoids and back; the paratoids are oval, smooth-edged, and underlined in black laterally.

Ecological Notes. Thirteen of our 14 individuals were collected in evergreen forest at 310 m, and one was taken in gallery forest. All specimens were collected away from streams, eight on the surface of dead leaves, two on bare soil, and four on small rocks. Eleven specimens were found during the day and three at night.

Bufo melanostictus Schneider

Bufo melanosticus Schneider, 1799, Hist. Amphib., p. 216 — East India.

Material. 4 adult females 45.3-58.1 mm SV, mean 52.8. Tibia 0.37-0.43 of SV. All contained numerous pigmented ova.

Ecological Notes. An inhabitant of cleared or disturbed habitats, including rubber plantings, forest edges, and human habitations. Individuals were collected from sea level to 900 m, and numerous additional specimens were seen but not collected, especially in the immediate vicinity of human dwellings.

Bufo parietalis Boulenger

Bufo parietalis, Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 312, plate 21, fig. 22 — Malabar.

Material. 7 adult females 73.7-92.2 mm SV, mean 82.4; 4 adult males 50.1-59.9 mm, mean 54.7; 11 subadult females 55.9-66.1 mm; 67 juveniles 14.6-45.3 mm. Tibia 0.37-0.40 of SV in females, mean 0.385; 0.38-0.42 in males, mean 0.396.

Very little has been published on this toad since its original description. Adults have a uniform light brown dorsum with a few large warts, usually tipped with black. A dark line extends from the orbito-tympanic crest along the lateral edge of the paratoid gland, and is present even in small juveniles. The sides are

dark brown marbled with tan. The cranial crests are extremely well developed in adults, with the paratoid ridge meeting the paratoid gland. The crests become progressively keratinized and blackened with age, starting with the supraorbital crest in young adults, until all crests are heavily keratinized in large specimens. The young lack cranial crests. To distinguish them from sympatric toads, see *B. beddomi.*

Ecological notes. Fifty-four individuals were collected from evergreen forest, 24 from moist deciduous forest, 2 in secondary growth and 3 in semi-evergreen forest. Twenty-three were caught below 200 m elevation, 56 at 250-400 m, and 4 at 950 m. Most toads were found away from streams in the forest (68 specimens); 12 were collected along stream banks, and two were in the water of streams. Forty-five individuals were collected on the surface of dead leaves, 14 on bare soil, and 10 on rocks; the remaining individuals were either under leaves, rocks, or soil (7) or on logs or low plants (3). Only one female (86.2 mm) contained mature ova.

Pedostibes tuberculosus Günther

Pedostibes tuberculosus Günther, 1875, Proc. Zool. Soc. London, 1875: 576, pl. 64, fig. C — Malabar.

Material. 1 adult female 38.5 mm SV. 1 adult male 36.6 mm, 16 juveniles 11.1-21.9 mm. Tibia 0.44 of SV in female, 0.40 in male. Ova in the female were very small.

Ecological Notes. Sixteen of our 18 individuals were collected in evergreen forest at 300-310 m elevation, 1 in moist deciduous forest (255 m) and 1 in moist semi-evergreen forest (260 m). We found 11 individuals away from streams and 7 within 6 metres of a permanent stream. Seven were on dead leaves, 2 on bare soil, 5 on small rocks, 3 on leaves of herbaceous plants, and 1 on a shrub. Our limited observations suggest that these toads stay on or near the ground during daylight hours (9 were collected on the forest floor), then move to arboreal situations at night (3 on leaves of small shrubs). However, we also found one individual 1.5 m above ground in a shrub during daylight hours, and one of our four night captures was on a 10 cm rock on the ground, suggesting that this temporal habitat selection is not perfect.

Ramanella triangularis (Günther)

Callula triangularis Günther, 1875, Proc. Zool. Soc. London, 1875: 576 — Malabar.

Ramanella triangularis Rao and Ramanna, 1925, Proc. Zool. Soc. London, 1925: 1445.

Material. 1 adult female 30.3 mm SV; 4 adult males 23.4-25.8 mm, mean 24.2. Tibia 0.42 of SV in female; 0.42-0.47 in males, mean 0.44. The female was gravid.

Taxonomic Notes. According to Parker (1934), *R. triangularis* is distinguished from *R. variegata* (Stoliczka) on the basis of toe webbing (a rudiment in *R. variegata,* toes completely free in *R. triangularis*), ventral coloration (immaculate white in *R. variegata,* dark brown with small, white spots in *R. triangularis*), and the dorsal color pattern. *Ramanella triangularis* has a characteristic dark lateral streak at the loreal region and a dark dorsal median blotch that bifurcates in the coccygeal region. The color pattern of *R. variegata* is dark brown with irregular lighter marblings or spots, but no consistent pattern (Parker 1934, Daniel 1963). Our specimens agree with *R. triangularis* in ventral coloration and in some details of the dorsal color pattern, particularly in the dark triangular blotch between the forelimbs. However, the paired dark bands posteriorly and the triangular dark spot enclosing the anus are both variable. In addition, our specimens have vestiges of webbing on the toes, extending to the proximal sub-

articular process of the third, fourth, and fifth toes. Thus, while we identify these frogs as *R. triangularis* on the basis of color pattern, they actually represent a composite of key characteristics of both species, and suggest that rediagnosis of the two species may be needed.

Larvae. Eleven samples of a larval microhylid were obtained from tree holes. None is older than Stage 27, so that diagnostic features of adult limb form are not available. Of the microhylid genera known from South India, the only one that has arboreal habits is *Ramanella* (Daniel 1963). Since it is not likely that any of the other, terrestrial genera would consistently deposit eggs in tree holes, we believe that these are larval *Ramanella.*

Larvae have been assigned to *R. triangularis* (Rao 1918, Parker 1934), with no explanation for this decision. Rao gave no information on habitat. Our tadpoles differ from Rao's in several respects. First, they are blackish, heavily pigmented dorsally, laterally, and under the fore part of the body. Rao's tadpoles were transparent, becoming brown in metamorphic stages. Secondly, the Ponmudi larvae have the spiracular tube extended to the end of the body so that the opening overlies the end of the anal tube; Rao's figure shows the spiracle opening almost midway between the level of the eyes and the end of the body. Description of our larvae follows.

Head-body broadly oval, almost truncate at snout, body depressed, maximum width at mid-body; eyes lateral, but not visible from below; eyeball very small in these stages; interorbital about 0.6 of head-body width, at least 1.5 times eye-snout distance; nostrils not open, internarial 1/4-1/3 of interorbital; nasolacrimal duct not visible. Mouth terminal; neither lip expanded; no beaks or denticles; upper lip with obtusely pointed, down-turned lateral lobes separated by wide, curved median indentation; lower lip supporting a U-shaped flange projecting into buccal cavity with median portion forming part of exterior surface of mouth just below center of upper lip. Spiracle median, opening wide, overlying end of anal tube. Anal tube median, in ventral fin running diagonally from end of body to margin of fin. Tail weakly convex, tapering gradually to narrow tip; both fins arising at end of body; fins deeper than muscle in distal two-thirds; ventral fin deeper than dorsal. Head-body black above, laterally, and under anterior half or two-thirds; no pattern; caudal muscle and dorsal fin dusky; ventral fin usually without pigment.

Head-body length (mm) at Stage 25 7.1 (maximum), at Stage 27 9.2-9.25. Maximum total length 25.5 mm. Tail length 1.56-1.76 of head-body length. Head-body width 0.68-0.88 of length; body depth 0.62-0.67 of width; eyeball 0.06-0.07 of head-body length.

Ecological Notes. All 5 adults were taken from two tree holes in the same tree 2-4 m above the ground in an isolated patch of evergreen forest at 950 m above sea level. Tadpoles were collected in the same tree holes as well as in others 0.3-1.0 m above ground at 310-510 m above sea level.

Micrixalus fuscus (Boulenger) (Plate I)

Ixalus fuscus Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 96, pl. 10, fig. 3 — hills of southwestern India.

Micrixalus fuscus Boulenger, 1888, Proc. Zool. Soc. London, 1888: 205.

Micrixalus herrei Myers, 1942, Proc. Biol. Soc. Washington, 55: 71 — Kallar. Trivandrum District.

Material. 50 adult females 21.5-28.8 mm SV, mean 25.2; 126 males 17.6-21.2 mm, mean 19.5; 71 juveniles and subadults 11.3-20.8 mm. Tibia 0.49-0.56 of SV in females,

mean 0.534 (n=10); 0.55-0.62 in males, mean 0.566 (n=10). Males have large, cream-coloured nuptial pads.

An extremely variable species, showing a wide range of variation in color pattern and amount of webbing of the feet. Dorsum in life light tan to dark reddish brown to nearly black, with various amounts of black marbling or spotting. Ventral color yellow-tan, with or without brown reticulations, especially in the throat region. Thin dorsolateral fold white, black, or similar in color to the tan background. A light thigh stripe extending from anus nearly to inside of the knee joint always present, even in very small juveniles, sometimes interrupted. In life, thigh stripe deep yellow. Females bright yellow in the groin and on anterior face of the thigh; males have the yellow less developed. Dorsal surfaces of the feet bluish-gray.

Webbing of the hind feet varies from about three quarters (Daniel 1963) to nearly complete. The variation found in this species, especially in the extent of hind foot webbing, would be sufficient to distinguish a separate species if only the extremes were considered. However, since no clear break in the amount of webbing exists, and it is not correlated with color pattern or other variation, we conclude that this entire sample represents a highly variable, continuous population.

Eggs of most females were enlarged, ripe, and unpigmented. Males have large nuptial pads.

Taxonomic Notes. Myers (1942b) named *M. herrei* on the basis of a single male taken from Kallar, a few kilometres from several of our collecting sites. These two species were differentiated by Myers on the basis of six characters: 1) longer legs of *herrei*, 2) dorsum granular in *herrei*, 3) snout more rounded in *herrei*, 4) a relatively larger eye in *herrei*, 5) *herrei's* much smaller size, and 6) certain differences in details of coloration. In comparing the type and only specimen of *M. herrei* (CAS SU 7265) to our large series, we find that most of the diagnostic features are variable in our series. Characters 1 and 5 are sexually dimorphic in this species, and the type of *herrei* is well within the range of our series of males. Likewise, the color pattern differences between the two disappear when a large series is examined. The granular surface of *herrei*, as Myers suggested, is primarily a function of the drying out of a specimen, and an individual changes from "smooth" to "granular" in the course of a few minutes of dessication. The shape of the snout in our material is more similar to *M. herrei* than the figure of *M. fuscus* in Boulenger (1882), with the nostrils slightly interrupting the line of the canthus rostralis. However, this difference is extremely slight. The eye diameter relative to the distance from eye to snout is large in *M. herrei* (3.0 : 2.5 mm), as Myers indicated. This character is sexually dimorphic in our sample, and females have relatively smaller eyes than males. In a ramdom sample of 12 individuals, the largest eye size was 2.9:2.7 mm, and on average the ratio is about 1:1. It thus seems likely that Myers' type represents nothing but a slightly large-eyed male *M. fuscus*, and that specific designation is unwarranted.

Ecological Notes. Of the 239 specimens for which we have ecological data, most (222) were taken in evergreen forest (2 below 200 m, 192 at 200-400 m, 28 at 401-750 m). The rest were found in moist deciduous forest (13), moist semi-evergreen forest (1), or secondary growth (1) between 70 and 400 m. A single individual was collected at 950 m in gallery forest. About a third of our specimens were found away from streams in the forest; the

remainder were collected either in the water (8), on rocks in midstream (30), or along the banks (122) of permanent and intermittent streams. Most individuals were found on the forest floor, either on rocks (115), dead leaves (71), or on bare soil (9); the rest were taken above ground in low plants (22) or under dead leaves (7). A large concentration of this species was always present in a seepage area, with flowing water 2-5 cm deep, and several pairs were found in amplexus in this area.

Micrixalus nudis Pillai

Micrixalus nudis Pillai, 1978, Proc. Indian Acad. Sci., 87B: 173 — Chedleth, Kurichiat Reserve Forest, Wynad, Kerala.

Material. 6 adult females 18.1-19.7 mm SV, mean 19.2; 6 adult males 15.2-15.6 mm, mean 15.4. Tibia 0.47-0.51 of SV in females, mean 0.494; 0.49-0.53 in males, mean 0.511. Males have a well developed nuptial pad. All six females contained large well-developed, unpigmented ova.

This sample matches Pillai's (1978a) description, and represents the second series of the species. The only disparity with the type series is in the extent of webbing on the hind feet. Our specimens have only a rudiment of webbing, while Pillai's series was about half webbed. However, in size, details of color pattern, and other aspects of morphology, the agreement is nearly perfect. The extensive variation in webbing found in our large sample of *M. fuscus* from Ponmudi suggests that this character may be relatively variable in this genus.

Ecological Notes. We found these frogs at 250-900 m elevation, in evergreen (5), moist deciduous (3) and gallery (4) forests. Half of the individuals were found away from streams; the rest were in small streams (1) or along stream banks (5). We collected 5 specimens on rocks, 2 on dead leaves, 2 on tree trunks, 1 on bare soil, and 1 on a fallen log.

Pillai's (1978a) report of pairs in amplexus in late October, combined with our observations, suggests that these frogs breed at least throughout the monsoon season (May-October).

Our specimens extend the range of *M. nudis* approximately 350 km southward, and suggest that the species is widely distributed throughout the Western Ghats.

Nannobatrachus beddomi Boulenger

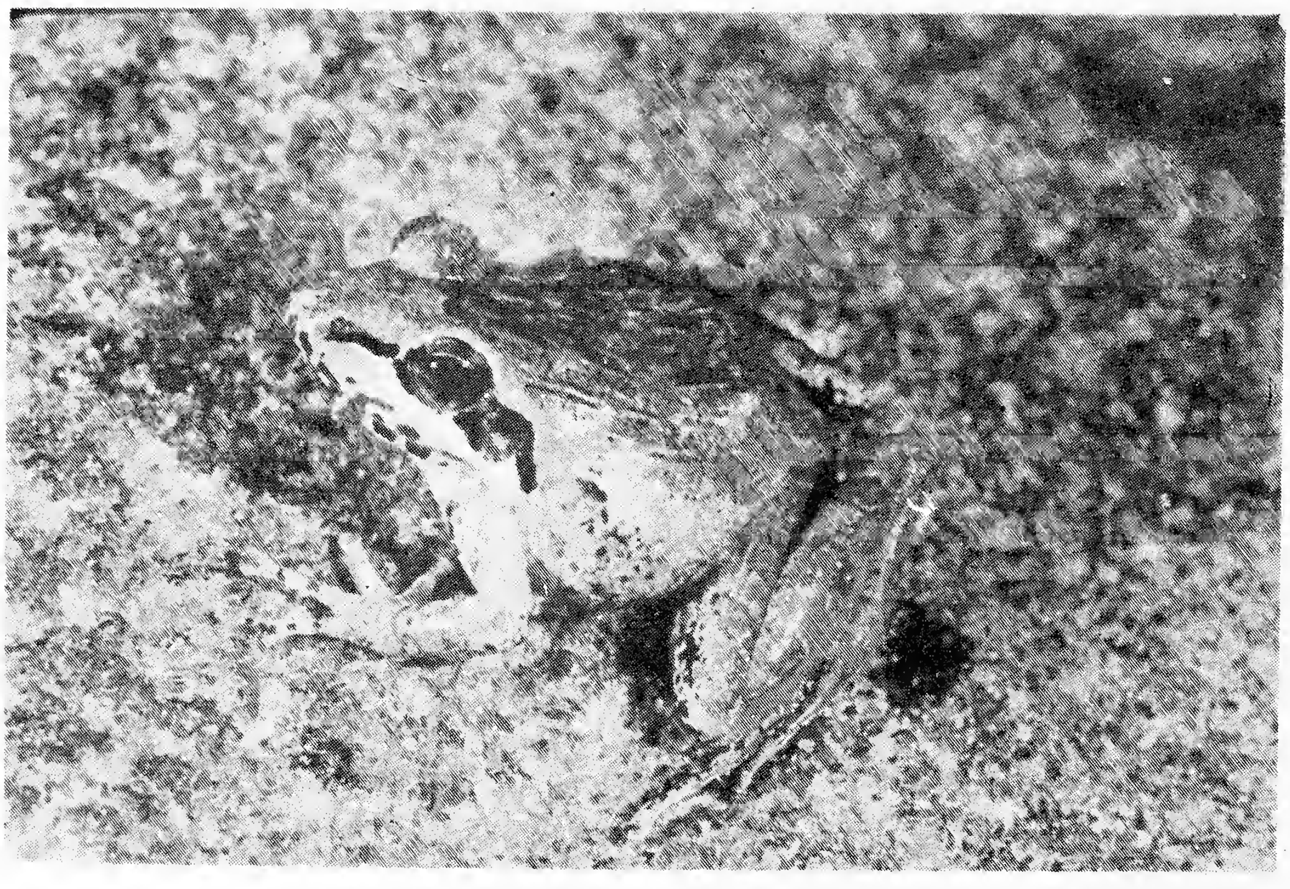
Nannobatrachus beddomii Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 470 — Malabar and Tinnevelly.
Nannobatrachus anamallaiensis Myers, 1942, Proc. Biol. Soc. Washington, 55: 49 — Puthutotam Estate, Valparai, Tamil Nadu.

Material. 10 adult females 14.5-17.1 mm SV, mean 15.7; 8 adult males 13.6-15.2 mm, mean 14.5; 4 juveniles and subadults. Tibia 0.45-0.49 of SV in females, mean 0.470; 0.45-0.51 in males, mean 0.483.

Our sample agrees well with the original description as emended by Boulenger (1883). A stout, squat species with a broadly rounded snout, no canthus rostralis, large, well-separated eyes with very small eyelids. Skin perfectly smooth dorsally and ventrally; a few small conical tubercles may be present on the eyelids. Toes long and slender, with small, oval disks and no trace of webbing. Toe disks with longitudinal division dorsally, and a strong circummarginal groove. No groove on the finger disks. Tympanum completely hidden in some individuals, barely visible in others, and about half the diameter of the eye.

In life, back brown with black markings; throat and abdomen grayish. A pale, bluish-white streak behind and below eye, and an irregular series of similar spots along sides of neck and torso. A tan, triangular patch on the snout

Above: Micrixalus fuscus.
Below: Nyctibatrachus major, showing diamond-shaped pupil.



Above: Nyctibatrachus minor, new species.
Below: Rana brachytarsus.

between eyes. Front and hind limbs strongly barred with dark brown crossbands.

Of 11 mature females, 8 contained large, pigmented, black and tan ova and a few small white ones, while three contain only small, unpigmented ova. Males have the relatively largest and most strongly developed femoral glands[4] of any species in our collection. The glands are oval, raised, enamel white in color, and about two-thirds the length of the femur. However, in one male the glands are much less developed; they are barely raised above the surface of the thigh and have lost most of their distinctive white color.

Taxonomic Notes. We have compared our material with a cotype of *N. beddomi* (FMNH 73344) and with part of the type series of *N. anamallaiensis* Myers (CAS 7199, 7200, 7202, 7204). The remaining species of the genus, *N. kempholeyensis* Rao was not available for comparison. Our material agrees in nearly every detail with the *N. beddomi* cotype, and is clearly assignable to that species. However, the differences between *N. beddomi* and *N. anamallaiensis* cited by Myers are extremely slight.

Myers (1942a) cites the shape of the pupil, the relatively shorter hind leg, and the shape of the vomerine tooth patch (linear in *anamallaiensis,* oval in *beddomi*) as the only differences between these two species. As Rao (1937) and Pillai (1978b) have pointed out, the shape of the pupil in preserved frogs is too variable to be of much systematic value. In our series, 16 specimens have perfectly round pupils; the rest vary from slightly oval to diamond-shaped, similar to the condition we observed in living examples of *Nyctibatrachus* (Plate I). Several specimens had one round pupil and the other oval shaped. There is also considerable variation in the shape of the vomerine tooth patch in our material. These tiny frogs have only 5-10 teeth per patch, and the eruption of a few teeth can completely change a patch from linear to oval. Hind limb length, especially when measured as the position the tibio-tarsal joint reaches along the head, is also variable, depending on the amount of food in an individual's stomach or the ova in a female. Measured as the overlap of the heels when the femurs are at right angels to the body, measurement error is much less, and both *anamallaiensis* and *beddomi* have legs of equal length, with the heels just or not quite meeting at the anus. We feel, therefore, that *N. anamallaiensis* is a junior synonym of *N. beddomi,* and that Myers' detailed description of the former may be used as a needed redescription of *N. beddomi.* No traces of femoral glands or enlarged ova are in evidence in Myers' four examples. They were collected in January, which is apparently not a part of the breeding season. Thus, the femoral glands may well be strictly seasonal in occurrence.

As Myers (1942a) suggested, the generic relationships and distinctiveness of *Nannobatrachus, Nyctibatrachus,* and *Nannophrys* are problematical. Of the characters first used to separate these genera, pupil orientation can no longer be considered of systematic value. Toe webbing, cited by Myers as a feature of *Nyctibatrachus,* is also no longer valid, since a new species described below lacks webbing. Two previously unused characters, which we describe for the five species available to us, are the presence of femoral glands in males and the presence of pigmented ova in reproductively mature females. These characters, when considered in combination with the pre-

[4] We are grateful to Mr. Barry Clarke, British Museum (Natural History), for calling our attention to the femoral glands in *Nyctibatrachus,* leading us to look for these structures in *Nannobatrachus.*

sence of skin folds and webbing, allow an unambiguous characterization of all five taxa (see Table 1). However, they do not help diagnose *Nannobatrachus* and *Nyctibatrachus*. Further analysis of the osteological characters used by Boulenger (1882) and Myers (1942a) may help resolve this problem.

femoral glands in sexually mature males, toes three-fourths webbed, and dorsal coloration of brown and tan with light dorsolateral bands.

Holotype. Field Catalogue number RFI-31300, an adult female collected 1 June, 1982 from Ponmudi, Trivandrum District, Kerala, 350 m elevation. Deposited in NMNHI.

TABLE 1

COMPARISON OF PONMUDI SPECIES OF *Nannobatrachus* AND *Nyctibatrachus* WITŒ EACH OTHER AND WITH *Nyctibatrachus pygmaeus*

Species	Ripe Ova	Femoral Glands	Skin Folds	Webbing*
Nannobatrachus beddomi	pigmented	strong	absent	< 1/4
Nyctibatrachus major	pigmented	strong	present	3/4
N. aliciae	pigmented	weak	present	3/4
N. pygmaeus	pigmented	strong	present	1/2
N. minor	unpigmented	absent	present	< 1/4

* Extent of webbing relative to subarticular tubercles of fourth toe : < 1/4 = not beyond basal tubercle; 1/2 = to middle tubercle; 3/4 = between middle and distal tubercles.

Ecological Notes. We collected specimens in evergreen forest (13 at 260-365 m, 4 at 450-660 m), moist deciduous forest (2 at 280-290 m), moist semi-evergreen forest (2 at 260 m), and high-altitude gallery forest (1 at 900 m). Eight specimens were taken along stream banks, 12 away from streams, and one in the dry bed of an intermittent stream. About two-thirds of our specimens were collected beneath cover (6 under leaves, 6 under rocks, 1 under soil); the rest were on dead leaves (3) or bare soil (2).

Nyctibatrachus aliciae[5] sp. nov.

Diagnosis. A medium-sized *Nyctibatrachus* which can be distinguished from all other forms by its intermediate size at sexual maturity (mean SV for males 22.7 mm, for females 26.5 mm), presence of weakly developed

Paratypes. 24 adult females, 8 adult males, 2 juveniles. FMNH 216582-602; 13 deposited in NMNHI.

Description of holotype. Habitus squat and stout, as in other members of the genus. Snout rounded, no canthus rostralis. Nostrils close together, about one-third the distance from the tip of the snout to the eye, internarial distance slightly less than interorbital. Upper eyelids very reduced, covering less than one-quarter of the eyeball; interorbital distance more than twice the width of the eyelid. A well defined supratympanic fold from the middle of the posterior edge of the eye curving

[5] We take pleasure in naming this species for Dr. Alice G. C. Grandison, British Museum (Natural History) as a modest token of appreciation for her help not only to us, but to herpetologists around the world.

through a 90 degree bend to the shoulder. Tympanum completely hidden.

Forelimbs stout. Fingers long, slender, and unwebbed. Tips of the fingers dilated into small, round disks, only slightly larger than the diameter of the subterminal phalanx. A well developed circummarginal groove separating the dorsal and ventral surfaces of the disk extends almost around its entire circumference. Disks on all fingers with a dorsal longitudinal groove, the division very weak on the first finger, most pronounced on the third. Subarticular tubercles moderate; a series of three tubercles at the base of the metacarpals, the one under first finger largest.

Hind legs robust, short, the heels widely separated when the tibia are bent at right angles to the body. Tibia 0.49 of SV. Toes three-fourths webbed (see Daniel 1963, figure 12), webbing extending to disk of all but fourth toe on lateral sides, and to outer subarticular tubercle on fourth. Webbing extends slightly past distal subarticular tubercle on medial side of third toe and to base of disk on medial side of second. A thin fringe of webbing, which tends to fold over on the phalanx, from distal subarticular tubercle of fourth toe to disk. Disks much larger than on fingers, one and one-half times breadth of subterminal phalanx. A strong circummarginal groove; dorsally, all disks strongly divided.

Subarticular processes well developed, oval, and whitish-gray in color. A long, slender inner metatarsal tubercle, about three times as long as wide, and a small, white nearly round outer tubercle. A slightly crescentic tarsal fold extending from anterior edge of inner metatarsal tubercle about two-thirds distance to tibiotarsal joint. A low, spinose ridge along the lateral side of the foot, ending in outer metatarsal tubercle.

Skin loosely connected to underlying tissue, even on head and limbs. Dorsally an irregular series of short ridges completely covering the back and limbs; ridges on snout becoming longer and assuming a more or less parallel longitudinal orientation. A strong, well-developed ridge extending from the lip over the tip of the snout to between the nostrils, at which point it bifurcates, producing an inverted "Y"; the bifurcated ends extend half the distance to the eyes. Upper eyelids strongly tuberculate. Numerous tiny, white-tipped tubercles on the upper surface of the calves and tarsus and above the vent. Belly smooth, the throat with a series of longitudinal ridges sharply demarcated by a gular fold. The underside of the limbs smooth.

Dorsally a dark brown background with light, cream-colored blotches. Blotches coalesce into two broad, broken stripes extending from behind eyes to the groin, stripes about width of eyes. Another, more diffuse band of cream middorsally, interrupted with dark brown. A light, triangular spot of cream between the eyes, and a light blotch above the lip on each side. Both front and hind limbs barred with dark brown and cream; the hands almost entirely dark brown. Belly immaculate white, throat white with dark brown, longitudinal lines. Forelimbs white, edged with a fine pattern of dark brown vermiculations; this pattern of brown extends laterally along the sides of the belly, and completely covers the ventral surface of the hind legs. Hands and feet dark brown ventrally.

Snout-vent 32.0 mm, tibia length 15.7, head width 12.6.

Variation. The ratio of brown to cream on the dorsal surface varies considerably; the type represents an intermediate condition. However, in all specimens, even the smallest, some vestige of the two light bands on the back is always discernible; it is most obscure in very

light individuals, where it blends in with the background. Ventral coloration is somewhat variable, especially in the density of brown pigmentation on the throat and underside of the limbs; some individuals are virtually solid brown, while others have a very faint pattern of brown vermiculations. This variation is not sexually dimorphic; both males and females have dark throats.

Males possess a variable, but generally poorly developed, raised femoral gland ventrally on the thigh. In the best developed individual (FMNH 216594), the glands are about one-half the length of the thigh, twice as long as wide, and perfectly oval. Under magnification, the granular structure of the gland can be seen through the skin, although the surface of the gland is smooth. Males also possess a weakly developed nuptial pad on the inside of the first finger. The femoral glands are generally weakly developed, and in most cases are only barely visible. Since all females contained mature ova, both sexes are presumably at their height of reproductive activity, implying that the femoral glands are never strongly developed.

All females larger than about 25.0 mm possess some large, pigmented ova ready for laying, as well as a few small, unpigmented ova. Sexual maturity appears to be reached in females at 25 mm SV; two individuals at 23.9 and 23.6 mm had a few mature ova, but most were small and unpigmented, and other individuals less than 24 mm SV had only immature ova.

Measurements and body proportions are given in Table 2.

Table 2

Snout-vent length (mm) and tibia length and head width as proportion of SV in adults of *Nyctibatrachus aliciae*

	Females	Males
Snout-vent		
range	20.4-33.5	21.8-24.9
mean	26.5	22.7
Tibia length		
range	0.46-0.54	0.49-0.53
mean	0.501	0.504
Head width		
range	0.38-0.44	0.38-0.42
mean	0.404	0.395
Sample size	25	8

Comparisons. Five species of *Nyctibatrachus* have been described to date: *N. humayuni* Bhaduri and Kripalani, *N. major* Boulenger, *N. pygmaeus* (Gunther), *N. sanctipalustris* Rao (with two subspecies), and *N. sylvaticus* Rao. Of these species, all but *N. pygmaeus* are very similar to *N. major;* they are large (adults over 40 mm SV), generally dark with irregular dark mottling, and apparently represent slight variations from *N. major.* All of these species are readily distinguishable from *N. aliciae* on the basis of adult size and on dorsal color pattern. In our large series of sympatric *N. major,* a light banding pattern may be faintly visible in some juveniles, although they invariably become dark brown with age. The webbing on the hind feet is also less extensive in our *N. major* (see below).

Nyctibatrachus aliciae differs from *N. pygmaeus* in several characters. Besides the differences shown in Table 1, *pygmaeus* is smaller (3 syntypes 18.7, 19.1, 23.1 mm) and lacks expanded toe disks and dorsolateral light bands.

Ecological Notes. This species was distributed throughout the habitats sampled, from 105 to 840 m elevation. Most (28) were taken at 310-350 m in evergreen forest; in addition, 3 were collected at 650-660 m in evergreen forest, one from moist deciduous forest at 105 m, and 3 from an area of secondary

growth at 840 m. All of the specimens were taken in close association with water: 21 from the banks of permanent streams (generally within 1 m of the stream), 8 were on rocks in mid-stream, 5 were actually in the water, and one was in a temporary pool. We cannot say whether this species is always restricted to aquatic habitats, or if this distribution is a phenomenon of the breeding season.

Twenty of our specimens were collected on rocks, 4 on bare soil, and 3 on dead leaves. With two exceptions, all specimens were found after dark, suggesting that, like other members of the genus, this species is nocturnal.

Nyctibatrachus major Boulenger (Plate I)

Nyctibatrachus major Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 114, pl. 12, fig. 2 — Malabar and Wynad.

Material. 23 adult females 40.1-53.6 mm SV, mean 47.9; 35 adult males 36.3-51.8 mm, mean 43.6; 154 juveniles and subadults 14.9-37.3 mm, those 14.9-20.0 with vestige of tail. Tibia 0.47-0.53 of SV in females, mean 0.496 (n=12); in males 0.48-0.55, mean 0.512 (n=12). Head width 0.43-0.47 of SV in females, mean 0.451 (n=12); in males 0.43-0.47, mean 0.447 (n=12).

Pillai (1978b) has provided a recent redescription of *N. major* based on a series of 42 individuals from Wynad, one of the type localities, approximately 400 km north of our collecting locality. Because the description is relatively complete, we will only note points where our collection deviates substantially from Pillai's.

Our adult specimens range from light tan to dark brown, although light adults are uncommon. As Pillai noted, juveniles tend to be lighter than adults, although they also range from light yellow-tan to dark brown. In some juveniles (about 10%), a pair of diffuse, light cream lines extend from the eyes about half way to the vent on the dorsum, superficially resembling similar bands found in *N. minor* (see below). However, the bands are much wider and more diffuse in *major*.

Pillai (1978b) stated his specimens lack circummarginal grooves on the finger disks, but have both deep circummarginal grooves and longitudinal dorsal grooves on the toes. In our frogs the toes have very shallow, poorly defined grooves. It is impossible to determine how much of this difference is an artifact of preservation and how much is due to geographic variation.

Adult males have well-developed femoral glands. These glands are oval, about half the length of the femur, and one-half to one-third as wide as long. The glands are slightly raised, yellow-cream in color, and sharply differentiated from the skin of the surrounding thigh. Under magnification the glandules are visible through the skin, giving the area a granular appearance. Similar glands are also present in the type series of *N. major* (Barry Clarke, personal communication), and in several other species of *Nyctibatrachus* and *Nannobatrachus* (Table 1).

The smallest adult female (40.3 mm) had a few pigmented ova. All larger females contained ripe, pigmented eggs with black and cream colored poles, as well as a few small, white ova.

Larvae. Twenty-one samples of larvae ranging from Stage 25 to Stage 41 (Gosner 1960) agree closely with Pillai's description of larval *N. major* (Pillai 1978b). The principal difference between our larvae and those illustrated by Pillai lies in the labial lobes. In ours, the lateral portions of both lips are formed by wide lobes that flank 4 median lobes on the lower lip. As only a slight modification of Pillai's figure would bring it into correspondence with our tadpoles, we believe that this

difference is merely a matter of interpretation.

The limbs of pre-metamorphic larvae are like those of adult *major* in one particular feature that distinguishes that species from *N. aliciae*: the dorsal surfaces of the disks lack a longitudinal groove. In our samples, head-body length measured 13.33-14.16 mm in the largest Stage 25 larvae, 17.25-17.75 at mid-development (Stages 32-36), and 16.67-18.0 near metamorphosis (Stages 40-41). Tail lengths varied from 1.90 to 2.25 times head-body length, and maximum tail depth from 0.21 to 0.26 of tail length. Transforming individuals with tail stumps varied from 14.9 to 19.4 mm SV.

Ecological Notes. Altitudinal distribution was extensive: 110 m — 1, 240-290 — 8, 310-365 — 152, 630-660 — 36, 840-920 — 6. Half (106) of the transformed individuals were captured in water; the remainder were on stream banks or in seepage areas. As these hill streams have rocky banks, it is not surprising that a third (34) of those seen out of water were on rocks; others were on sand (25), on dead leaves (18), under dead leaves (14), under rocks (4), on logs (2), on the base of a tree (1), and on a low herb (1). About half of the total sample was obtained during daylight hours, including half (51) of those captured in water, all of those from under dead leaves, and two-thirds of those from sandy banks.

One tadpole was found in a pothole of a rocky stream bank, 31 (5 samples) in side pools of streams, 29 (1 sample) in a bank seepage, 106 (12 samples) in shallow pools with weak to moderate current, and 2 (2 samples) in seepages close to small streams.

Nyctibatrachus minor sp. nov. (Plate II)

Diagnosis. A small species of *Nyctibatrachus* which may be distinguished from all other forms by its small size at sexual maturity (maximum SV about 22 mm), the complete absence of webbing on the hind feet, the presence of a distinct, dorsolateral glandular fold, the lack of femoral glands in sexually mature males, and lack of pigment in mature ova.

Holotype. Field number RFI 31175, an adult female collected 30 May, 1982, from Ponmudi, Trivandrum District, Kerala, at 350 m elevation. Deposited in NMNHI.

Paratypes. 3 adult females, 18 adult males, 9 juveniles and subadults. FMNH 216603-18; 14 deposited in NMNHI.

Description of holotype. Habitus squat and flattened. Snout rounded, no canthus rostralis. Nostrils dorsal, raised slightly above the snout. Internarial distance approximately equal to interorbital distance; nostrils about equidistant between orbit and tip of snout. Upper eyelids extremely reduced, covering less than one-quarter of the eye; interorbital distance three times width of eyelid. A faint, interrupted supratympanic fold. Tympanum indistinct, the anterior border barely visible as a small crescent well separated from the eye.

Forelimbs stout, fingers moderate, with no vestige of webbing. Third finger longest, second and fourth subequal. Fourth more slender than others. Thumb short and robust. Tips of the fingers expanded into very small disks slightly wider than subterminal phalanx. No circum-marginal groove separating the upper and lower surfaces of the fingers. A weak dorsal groove on the left third finger; otherwise, disks without a longitudinal dorsal groove. Subarticular processes weakly developed, barely distinguishable from the ventral surface of the fingers.

Hind legs stout, moderately short; the tibiotarsal joints meet but do not overlap when the legs are bent at right angles to the long axis of the body. Tibia 0.48 of SV. Toes long and slender, with no vestige of webbing between them. Tips of toes expanded into small, oval disks, slightly wider than subterminal phalanx.

Disks with a strong, longitudinal, dorsal groove; no circummarginal groove separating the upper and lower surfaces of the toes. Subarticular processes poorly developed; a small oval inner metatarsal tubercle. A very short, crescentic fold extends from the inner metatarsal tubercle proximally about the length of the tubercle, then running in a straight line along the long axis of tarsus for about an equal distance. A smooth ridge extends along the outer edge of the fifth toe from its tip to the level of the inner metatarsal tubercle.

A series of well-defined, glandular ridges on head and back. A ridge extends from upper lip along midline of snout to between nostrils, at which point it bifurcates into a pair of ridges extending nearly to each eye. A pronounced transverse ridge between eyes. A pair of curved, dorsolateral folds from behind eyes, forming an hourglass pattern extending three-quarters of distance to groin. An additional pair of ridges forms an "X" pattern on anterior half of back, starting at same level as dorsolateral fold, but contained within them. A faint, interrupted supratympanic fold from eye to near shoulder.

Upper surface of arms and legs with irregular folds extending length of limbs. Some extremely minute granulations on eyelids and dorsal surface of head; otherwise, skin smooth. Ventrally, skin smooth.

Snout-vent 21.5 mm, tibia length 10.4, head width 8.4.

Color above light tan with dark brown markings surrounding most of longitudinal folds. A pronounced dark line between nostril and eye, a dark line between eyes, a brown "X" on the anterior half of the body. Anterior and posterior quarters of dorsolateral folds dark brown, area between folds light tan. A thin, white band along inside of anterior half of each dorsolateral fold. A few additional smudges of dark brown on the sides, and a white spot at the corner of the jaw just below each eye. Forelimbs strongly barred with dark brown; hindlimbs uniform tan. Beneath immaculate white with an extremely fine speckling of black along margins of body, limbs, and lower jaw.

Variation. The ground colour varies from nearly uniform chocolate brown to very light buff; the type is near the light side of this range, and represents the modal color. The striping pattern of the holotype is common to all individuals, even the smallest juveniles. However, different aspects of the pattern are more or less distinct depending on the background color. In dark individuals, the pair of white lines following the dorsolateral folds are extremely distinct, while the dark markings are relatively obscure; the opposite is true of light individuals. Some specimens have a distinct pattern of dark brown crossbands on the hind limbs as well as the forelimbs, and in some the dark lines surrounding the dorsolateral folds may be uninterrupted for their entire length. The ventral coloration is always immaculate white.

All females contained large, mature, white ova. Males have no external secondary sexual characters, and lack the femoral glands found in the other members of the genus (Table 1).

Metamorphosis apparently occurs at a very small size; our smallest individual (7.7 mm SV) has only a slight vestige of the tail above the anus. The tadpole has not been positively identified.

Comparisons. Of the five species of *Nyctibatrachus* previously described (see *Comparisons* of *N. aliciae*), four are clearly closely allied to *N. major* and may be distinguished from *N. minor* on the basis of size (all are about 40 mm SV, while the largest *N. minor* is 21.5 mm SV). The only species of com-

parable size is *N. pygmaeus* (Gunther). We have compared our material to 3 syntypes of *N. pygmaeus* (BMNH 1947.2.4.47, 1947.2.4.51, 1947.2.4.57). *Nyctibatrachus minor* differs from them in lacking webbing on the hind feet (*pygmaeus* is half to two-thirds webbed), in the pattern of glandular ridges on the head (the ridges are irregular and short in *pygmaeus*), in having a dorsolateral glandular fold (a few, broken ridges may be present in *pygmaeus*, but never a continuous fold), in the distinctive color pattern, and in being immaculate white beneath (*pygmaeus* is light brown). *Nyctibatrachus minor* differs from *N. aliciae* in size, color pattern, webbing of the hind foot, in lacking femoral glands in males, and in the females having unpigmented, mature ova. The last two characters are apparently unique for the genus (Table 1).

Measurements and body proportions given in Table 3.

Pillai (1978b) suggested that the presence of circummarginal grooves on the disks of the toes may be a useful generic character for

Table 3

Snout-vent length (mm) and tibia length and head width as proportion of SV in adults of *Nyctibatrachus minor*

	Females	Males
Snout-vent		
range	20.4-21.5	15.1-18.2
mean	21.1	17.3
n	4	18
Tibia length		
range	0.47-0.51	0.48-0.53
mean	0.486	0.501
n	4	10
Head width		
range	0.38-0.40	0.39-0.42
mean	0.395	0.405
n	4	10

Nyctibatrachus. However, such grooves are weakly developed or absent in some individuals of our *N. major* sample, well-developed in *N. aliciae*, but absent in *N. minor*.

Ecological Notes. All specimens were collected in evergreen forest at 310-375 m elevation. Since similar habitats were searched at higher elevations, we conclude that *N. minor* is restricted to relatively low elevations. Of the 30 specimens for which we have ecological data, all but 5 were collected either in or immediately adjacent to small streams or seepage areas, both by day and night. A favored microhabitat site was on or under dead leaves in seep areas (22 individuals), a position from which males were often heard calling.

Nyctibatrachus sp.

Two tadpoles having the characteristic oral disk of *Nyctibatrachus* (Bhaduri and Kripalani 1955, figs. 5 and 6; Pillai 1978b, fig. 1B) differ from any described to date. Because of their stages of development, they cannot be assigned to a species of adult.

Nyctibatrachus sp. *A*

A single tadpole in Stage 36 captured in a seepage area on a steep slope at 375 m above sea level. It differs from larval *N. major* in having only two median lobes on the lower lip (instead of 4), a smooth margin on the upper median lobe, the origin of the dorsal fin about two-thirds of head-body length behind the end of the body, and much narrower fins. It also differs from larval *N. humayuni* in all the preceding characters except the first. The limbs are not sufficiently developed for comparison with adults.

Head-body oval, snout rounded but narrower than in *N. major*, body flattened above, rounded below; maximum width midway between eyes and end of body, 0.60 of head-body

length, depth 0.85 of width; eyes dorsolateral, not visible from below, eyeball 0.12 of head-body length; interorbital 0.29 of head-body width, subequal to eye-snout distance; nostrils dorsolateral, open, rim with a distinct mid-dorsal projection, internarial distance slightly narrower than interorbital. Oral disk ventral, subterminal, without denticles; 0.32 of head-body width; lips expanded and lobulate; a wide lateral lobe forming lateral third of the disk; upper lip with a single wide median lobe about 1.5 times width of lateral lobes, notches separating median from lateral lobes deep; lower lip with a pair of narrow median lobes marked by shallow notches; margins of all except upper median lobe with single row of short papillae; a band of indistinct, short inframarginal papillae across bases of lower median lobes; a row of 7 short papillae across base of upper median lobe; upper beak gently curved, black along its margin, finely serrate; lower beak V-shaped, black along its marginal third, serrae longer and coarser than those of upper beak. Spiracle sinistral, midway up side, tube free from body wall near tip, snout-spiracle distance 0.49 of head-body length. Anal tube dextral. Tail 2.59 times head-body length; heavily muscled, margins straight, tapering gradually to narrow tip; maximum depth 0.16 of tail length; caudal muscle 2-3 times deeper than fins except at tip; origin of dorsal fin far behind end of body. No glands visible. Lateral line pores in conspicuous rows along side of snout and around eye; in a dorsolateral row to end of body, continuing on tail at base of dorsal fin, and in a ventrolateral row continuing along middle of caudal muscle.

Tadpole greyish brown, with small dark irregular spots over all surfaces except ventral fin and underside of head-body.

Head-body length 9.0 mm, total length 32.

Nyctibatrachus sp. *B*.

A single tadpole (Stage 25), caught in a pool of a small stream trickling over sand, differs from all larvae of *Nyctibatrachus* described or figured in having a much more slender habitus, very small eyes, a very narrow median lobe on the upper lip, inframarginal papillae across the lateral lobes of the upper lip, and fully pigmented, heavy beaks. The relatively small eye may be a function of small body size or early development. However, two Stage 25 tadpoles of *N. major* have much larger eyes (0.09 of head-body length as opposed to 0.03) and the observed range of relative eye size in *N. major* (Stages 25-41) is only 0.08-0.11. The other distinguishing features of this tadpole do not appear to be size-related.

Head-body an elongate oval, snout rounded but narrowed; strongly flattened above, weakly so below; maximum width in rear third of body, 0.52 of head-body length, depth 0.68 of width; eyes dorsal, very small, eyeball 0.03 of head-body length; interorbital 0.20 of head-body width, much less than eye-snout distance; nostrils dorsolateral, open, midway between eyes and tip of snout, a small mid-dorsal projection, internarial slightly wider than interorbital. Oral disk ventral, subterminal, without denticles, 0.39 of head-body width; lips expanded, lobulate; a single, narrow, median lobe on upper lip; 4 subequal median lobes on lower lip; remainder of both lips occupied by a wide lateral lobe; a single row of short, slender, marginal papillae on all lobes, those of median upper lobe distinctly narrower than others; a zigzag, transverse row of thick, short, inframarginal papillae across each lateral lobe of upper lip, papillae closer to beak than to margin of lip; a zigzag, transverse row of similar papillae across 4 median lobes of

lower lip, papillae closer to margin than to beak. Beaks heavy, completely black, margins coarsely serrate. Spiracle sinistral, half way up side, tube free from body near end, snout-spiracle distance 0.41 of head-body length. Anal tube dextral. Tail 2.07 times head-body length; heavily muscled, dorsal margin weakly convex, ventral margin straight, tapering gradually from middle to narrow tip; maximum depth 0.21 of tail length; caudal muscle much deeper than fins until distal fifth; origin of dorsal fin far behind body. No glands. Lateral line pores not visible.

Entire tadpole pinkish dark gray; caudal muscle dusted with melanophores with a few irregular pigment-free areas; dorsal fin with melanophores along juncture with muscle, otherwise fins without pigment.

Head-body length 9.25 mm, total length 28.1.

Rana beddomi (Günther)

Polypedates beddomi Günther, 1875, Proc. Zool. Soc. London, 1875: 571, pl. 43, fig. B. — Anamallai, Malabar, Sivagiri, Travancore.

Rana beddomi, Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 55.

Material. 9 adult females 45.1-60.1 mm SV, mean 49.4; 12 adult males 35.4-49.5 mm, mean 43.1, 15 juveniles 22.6-35.0 mm, Tibia 0.52-0.65 of SV in females, mean 0.627; 0.57-0.67 in males, mean 0.596. Tympanum 0.068-0.086 of SV in females, mean 0.078; 0.095-0.118 in males, mean 0.104.

Our specimens agree very closely with Günther's original description and figure. Webbing extending to disk on fifth toe and on lateral sides of toes 1, 2, and 3; medially, webbing extends to distal subarticular tubercle on second toe, and midway between first and second tubercles on third toe. Fourth toe webbed to second subarticular tubercle on both sides. Subarticular tubercles well developed. Dorsally, skin smooth or covered with fine granulations, more pronounced around anus and angle of jaw. A series of extremely thin, longitudinal folds on the back of some individuals. Ventrally, skin smooth, with a granular area on thighs near anus.

Coloration variable; the commonest pattern consisting of light pinkish-tan background with an irregular speckling of dark brown. In some individuals, dorsal background color dark brown. A black streak along supratympanic fold from eye to shoulder, continuing forward along canthus rostralis to nostril. A second dark streak anterior to tympanum from the lower margin of eye to jaw. Front and hind limbs faintly barred with dark brown, as are lips. Ventrally white with brown reticulations present on throat and sides of body; underside of legs immaculate yellow-white.

Males are smaller than females and have a much larger tympanum. In males, the tympanum is as large or larger than the eye; in females, it is about two-thirds the eye diameter. In addition, males have small, pointed spicules distributed along the margins of the jaw, throat, and lateral margins of the belly; in large males these may become brown and hardened. Males also have enlarged nuptial pads on the inside of the first finger.

All females below 30 mm SV were immature, while those above 50 mm contained enlarged, pigmented ova. Two 45 mm females contained both mature and immature ova, suggesting that sexual maturity is reached at about this size.

Taxonomic Notes. We use the name *beddomi* in the restricted sense of Günther (1875), and recognise *Rana brachytarsus* as a distinct species (see below). These two species are distinguished on the basis of amount of webbing and size. The smallest sexually mature *beddomi* female we have seen is 45 mm SV,

Plate III

Habitat of larval *Rana beddomi* at 900 m.

while the largest *brachytarsus* is 43 mm SV. In comparing our material to three syntypes of *R. beddomi* (BMNH 1947.2.27.73, 82, 84), we note that this small typic series is a composite of *R. beddomi* and *R. brachytarsus*. One of the syntypes (1947.2.27.73) has webbing as described above for *beddomi*. It is a female, 45.2 mm SV, with tiny, immature ova, and has not reached sexual maturity. The other two individuals have the more extensive webbing found in *brachytarsus* and are smaller: male 26.5 mm, female 39.3 mm. The female (1947.2.27.82) is sexually mature, with a thickened oviduct and ripe, pigmented ova. Thus, the first specimen is a subadult *R. beddomi*, while the other two syntypes are referrable to *R. brachytarsus*.

Larvae. Three samples of tadpoles, collected from rock faces, fit Annandale's (1918) description of larval *R. beddomi* very closely and agree among samples and with adult *beddomi* in having the third toe webbed to the middle subarticular tubercle and the fifth toe webbed to or almost to the base of the disk. As in the case of the tadpoles observed by Gravely (cited in Annandale 1918), those we collected made short, skittering jumps across the rock faces whenever they were closely approached.

The early development of the hind limbs, which Annandale (1918) inferred (correctly we think) on the basis of the wide range in size within stages 40-41, appears to be related to the skittering habit. Although used in this case to escape herpetologists (and other predators, presumably), probably the principal function of this behaviour is to enable the tadpoles to move from one tiny, shallow pool to another across slightly drier surface irregularities of the home rock face.

Head-body lengths (mm): 4.33 (Stage 30), 6.25-9.25 (Stage 40). Snout-vent: 6.75-12.6 (Stage 41), 11.9-13.9 (Stage 42), 12.0 (Stage 43), 13.9 (Stage 44). Total lengths: 17.5-17.8 (Stage 30), 22.5-26.4 (Stage 40), 27.3-30.2 (Stage 41).

Measurements on our specimens bear out Annandale's comments on the odd body proportions of larval *beddomi*. Their eyes are relatively larger than those of other tadpoles of tropical Asia, 0.16-0.19 of head-body length. The tail is long (2.5-3.3 times head-body length) and very slender (maximum depth 0.08-0.10 of tail length).

Denticle rows are 4+4/2+2:II in all but one of the 16 counted; the exceptional specimen had 5 divided rows on the upper lip.

Ecological Notes. We found most of our specimens in evergreen forest at 310-370 m (29 individuals); additional specimens came from moist deciduous forest (3 at 105 m), gallery forest (1 at 900 m), and moist semi-evergreen forest (1 at 260 m). Twenty-three were collected away from streams in forest, 11 along the banks and one in the water of permanent streams, and one in a dry stream bed. Fifteen frogs were collected on small rocks, 12 on dead leaves, and 5 on the soil surface; in addition, one each was found under the soil and on a log on the forest floor. Larvae were collected from rock faces over which a thin film of water flowed at 330, 890, and 900 m (Plate III). The highest site was completely open to the sky with the nearest trees about 10 m distant. The other sites were inside forests and shaded.

Rana brachytarsus (Günther) (Plate II)

Polypedates brachytarsus Günther, 1875, Proc. Zool. Soc. London, 1875: 572 — Anamallais and Sivagiris.

Material. 47 adult females 28.6-44.7 mm SV, mean 34.8; 25 adult males 25.1-33.7 mm, mean 29.5; subadult females 25.0, 25.3 mm.

Tibia 0.59-0.65 of SV in females, mean 0.621 (n=10); in males 0.64-0.84, mean 0.74 (n=10).

The webbing extends to the disk on the fifth toe and on the lateral sides of toes 1, 2 and 3. Medially, the webbing extends to the distal subarticular tubercle of the third toe, and to between the middle and distal subarticular tubercles of the fourth. The disks of the toes and the subarticular tubercles are less well developed than in *R. beddomi*. Dorsally, the skin is thrown into a series of longitudinal folds, which reach their densest concentration on the anterior portion of the back. These folds are much thicker and more prominent than in *R. beddomi*. Ventrally the skin is smooth, except for a granular patch near the anus.

Color pattern consists of a tan dorsal background with a variable number of short, longitudinal brown streaks. Some individuals have only a trace of this pattern, others are nearly completely brown. About 10% have a distinct, white middorsal stripe from the eyes to the vent. A dark brown band between the eyes is generally present. A black stripe follows the supratympanic fold and canthal ridge as in *R. beddomi*, and a second stripe, just anterior to the tympanum, connects the eye and upper lip. The limbs and lips are barred with dark brown. Ventrally white, rarely with a few brown spots on the throat. The legs are yellow on the ventral surface of the thighs and calves.

This species exhibits sexual dimorphism similar to that of *R. beddomi*, although it is less extreme. Males have enlarged nuptial glands on the inside of the first finger, and some males have spicules on the throat, lower jaw, and sides of the body, However, these are only rarely blackened, and more often the sides of the body have increased granulations rather than conical spicules. The spicules on the ventral surface of the feet are very dense in males and are usually blackened and stiff. In both males and females the tympanum is about two-thirds of the eye diameter.

All females above 28 mm SV contained enlarged, pigmented ova.

Taxonomic Notes. Boulenger (1882) considered *brachytarsus* (Günther) to be a synonym of *R. beddomi*, and all subsequent authors have followed this opinion. We clearly have two species closely allied to *R. beddomi*, separable on the basis of size, webbing, coloration, dorsal skin folds, and tympanic size and density of spicules in males. We have examined one syntype of *brachytarsus* (BMNH 1947.2.27.1307) which is similar to our sample in size (syntype a mature female 36.1 mm), dorsal skin folds, and tympanum size. The webbing of the syntype is somewhat less extensive than in our series, extending to the distal subarticular tubercle on the medial side of the third toe, and the dark canthal stripe is lacking. However, the syntype is from the Anamallai Hills about 200 km north of Ponmudi, and we attribute these differences to geographic variation.

We have not seen the second syntype of *brachytarsus*. However, on the basis of its size (55 mm, as reported by Boulenger 1920), it seems likely that the type series of *brachytarsus* is a composite of that species and *beddomi* just as is the type series of the latter (see above). We therefore designate the small female, BMNH 1947.2.27.1307, as the lectotype of *R. brachytarsus* (Günther).

Ecological Notes. This species has a broad ecological distribution. We found specimens from 100 to 950 m elevation (9 from 105-250 m, 35 from 260-350 m, 5 from 480-650 m, 22 from 860-950 m) distributed in evergreen forest (40), moist deciduous forest (10), gal-

lery forest (2), secondary growth (2), and open grassy areas (17). Most individuals (54) were collected away from water on the forest floor, although some were found in or along streams (18). Thirty-five were collected on rocks, 29 on dead leaves, 7 on bare soil, and 2 under dead leaves. Seventeen were caught in a seepage area at 900 m where a thin film of water flowed over exposed bedrock, and a number of calling males were taken from crevices in bedrock after dark.

Rana diplosticta (Günther)

Ixalus diplosticta Günther, 1875, Proc. Zool. Soc. London, 1875: 574, pl. 43, fig. 3 — Malabar.
Rana diplosticta Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 58.

Material. 4 adult females 23.6-25.2 mm SV, mean 24.6; 2 adult males 18.7, 20.0 mm. Tibia 0.56-0.62 of SV in females, mean 0.588; 0.60 in both males.

Toes less than one quarter webbed, webbing extending to proximal subarticular tubercle on medial side of third and fourth toes. Fingers and toes with large disks with strong circum-marginal grooves separating upper and lower surfaces. The back has a series of longitudinal folds; the head, sides, and belly are smooth. A strong, curved supratympanic fold from eye to shoulder. Tympanum well-developed in both sexes, about one-half eye diameter.

In life, this species is reddish-brown dorsally, with a black canthal and tympanic streak. The iris is greenish-gold above and black below, the line of demarcation coinciding with the upper edge of the dark canthal stripe. The dorsal color pattern is consistent among our six specimens and corresponds very well with Günther's (1875) figure. Above dark light tan with a dark brown band of varying intensity between eyes. Entire loreal region from canthus rostralis to upper lip is dark brown. Dark brown blotches may be present on the lateral surfaces; blotches symmetrically arranged on both sides of body. A dark brown spot invariably present just dorsal and anterior to the hind limb. Limbs tan crossbarred with dark brown. Ventrally light brown diffused with a fine reticulated pattern of dark brown, with most of the darker color concentrated on the throat and thighs. A dark brown triangular patch surrounding the anus.

All four females contain very large, pigmented ova with black and tan poles. Males have a series of 5 very large, black, sharp nuptial spines on the medial surface of the first finger. These spines were not noted by Boulenger (1920), who stated that males lack secondary sexual characters.

Taxonomic Notes. This small series is apparently the first collection of this species since those obtained by Jerdon and Beddome a century ago. Boulenger (1882) suggested that this species and *R. leptodactyla* may be conspecific, although he later (Boulenger 1920) treated them as full species. We have compared our material to syntypes of *R. diplosticta,* and the agreement with that species is very close. It is not known whether *R. leptodactyla* also has well developed nuptial spines in males.

Ecological Notes. All specimens were collected at 950 m elevation, far from streams or ponds. Five were found in evergreen forest, and a single specimen was in gallery forest. Three frogs were found under dead leaves, and one each on bare soil, dead leaves, and a rock.

Rana semipalmata Boulenger

Rana semipalmata Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 56, pl. 4, fig. 3 — Malabar.

Material. 3 adult females 32.0-35.5 mm SV, mean 33.6; 3 adult males 27.4-29.3 mm,

mean 28.3. Tibia 0.55-0.62 of SV in females, mean 0.576; in males 0.50-0.52, mean 0.510. Tympanum diameter 0.085-0.097 of SV in females, mean 0.092; in males 0.120-0.135, mean 0.127.

A small ranid, similar in general appearance to *R. brachytarsus,* but distinguishable on the basis of less webbing and size of tympanum. Webbing extends to the distal subarticular tubercle on the fifth toe and on the lateral side of the third, and midway between the proximal and the second subarticular tubercle on the fourth toe.

Dorsally tan or light brown, with longitudinal folds usually on the back. A dark brown stripe between the eyes. A broken U-shaped stripe open to the rear extends across the back from the level of the pectoral girdle. Limbs barred with black. No canthal stripe.

All three females contained pigmented, mature ova, and all 3 males have nuptial pads on the first finger and enlarged glands covering the ventral surface of the thighs. Males have a band of very small transparent spicules across the chest and around the margins of the jaw. Tympanum diameter is absolutely as well as relatively larger (see above) in males.

Taxonomic Notes. We have examined one of the two syntypes (BMNH 1947.2.29.51), a male that agrees very closely with our material. The syntype has nuptial pads and femoral glands. Boulenger's (1920) statement that males of this species lack secondary sex characters is in error.

Ecological Notes. We found 5 specimens in evergreen forest (4 at 330-360 m above sea level) and 1 in moist deciduous forest at 105 m. Three were collected 3-5 m from small permanent streams; the other 3 were well away from water in the forest. We found 2 frogs on dead leaves, 2 under leaves, and 2 on rocks. Two males were calling from seepage areas on exposed bedrock.

The large related species, *R. beddomi,* was found in sympatry with both small forms, *R. brachytarsus* and *R. semipalmata,* but the two last were found together only at one site at 105 m.

This is the first report of additional specimens of *R. semipalmata* since the original description.

Rana keralensis Dubois

Rana keralensis Dubois, 1980, Bull. Mus. Nat. Hist. Nat. Paris, (4), 2: 928 (replacement name).

Rana verrucosa Günther, 1875, Proc. Zool. Soc. London, p. 567 — Malabar.

Material. 1 adult female 50.6 mm SV, 6 subadult females 36.3-43.7 mm; 9 adult males 37.5-42.3 mm, mean 40.4; 24 juveniles 14.4-32.9 mm. Tibia 0.55-0.62 of SV in females, mean 0.585 (n=7); 0.55-0.62 in males, mean 0.572.

Dorsal coloration somewhat variable, although always light brown with dark brown bars across the body. A light tan vertebral stripe present or absent. The posterior side of the thigh is bright yellow marbled with black in life, dark brown marbled with white in preservative. Males have a well developed nuptial pad on the inner surface of the first finger. Of our 7 females, only the largest appeared to be sexually mature as she contained a few darkly pigmented ova. All of the other females contained only immature ova. Our smallest individual (SV = 14.4 mm) has a small vestige of its tail remaining, and presumably represents the size at metamorphosis.

Larvae. Five samples of tadpoles agreeing with Annandale's (1918) description (as *R. verrucosa*) were collected. A premetamorphic larva (Stage 41) has the webbing and foot form typical of adults, some of which were caught at the same site.

Head-body lengths (mm) : 6.6 (Stage 30),

9.75 (Stage 34), 11.25 (Stage 37), 9.67-11.1 (Stages 39-41). Maximum total length 29.8 mm (Stage 41). Head-body width 0.59-0.62 of length, depth 0.73-0.79 of width; Width of oral disk 0.35-0.39 of head-body width. Denticles I : 1+1/III, the outermost lower row two-thirds length of others.

Ecological Notes. As Daniel (1975) stressed, very little is known of the ecology of this species. We found all but one specimen at 100-300 m elevation, with a single frog taken at 710 m. The species inhabits a wide range of both disturbed and primary forest situations, including evergreen forest (22), secondary growth forest (13), moist deciduous forest (2), rubber plantation (1), and in a clearing (1). About half of our specimens (21) were collected away from water; the remainder were found in or along the banks of permanent streams (15) or in temporary rain pools (3). Individuals were always found on the ground, either on dead leaves (19), small rocks (4) or bare soil (6). About two thirds (26 of 40) of our specimens were found in small forest clearings, either along trails or roads, or in treefall areas. The samples of larvae were collected in water-filled silty ruts in a road through forest (3) and in pot-holes of rocky stream banks (2). Annandale also found tadpoles in a pot-hole alongside a stream.

(*to be continued*)

NEW DESCRIPTIONS

A NEW SPECIES OF *CRESPHONTES* STAL (HETEROPTERA: PENTATOMIDAE) FROM INDIA[1]

M. Nayyar Azim and S. Adam Shafee[2]

(*With a text-figure*)

Additional generic characters are proposed for *Cresphontes* Stal; *C. fulvus* sp. nov. fully described and illustrated. A key to Indian species of *Cresphontes* is also provided.

Genus **Cresphontes** Stal

Cresphontes Stal, 1867 : 514.

Type Species: *Rhaphigaster monsoni* Westwood

The distinguishing characters of this genus have been given by Distant (1902). Some additional generic characters are suggested which are as follows : last tergum in female (fig. 1, E) with anterior and posterior margins convex, lateral angles subacute. Female genitalia : external plates (fig. 1, F), first gonocoxae broad and subquadrate, inner margins straight; paratergites 8th triangular, 9th oblong and rounded apically. Male genitalia: pygophore (fig. 1, G) slightly wider than long, clasper (fig. 1, H) almost L-shaped; subgenital plate (fig. 1, I) narrow with anterior margin strongly convex, posterior margin broadly and deeply concave.

The genus is represented by two species from India including a new species. The two species are separated by the following key characters.

Key to indian species of *Cresphontes* Stal

1. Abdominal spine slightly extending beyond middle coxae; head and pronotum with dark puncts, arranged in patches; scutellum with dark shining patch medially, lateral margins and apex densely punctate; corium of hemelytra densely punctate; antennae with third, fourth and fifth segments black; apices of femora with black spots............*C. monsoni* Westwood

— Abdominal spine never extending beyond middle coxae (fig. 1, D); head and pronotum with reddish brown puncts uniformly and regularly arranged (fig. 1, A); scutellum without dark shining patch medially and sparsely punctate; corium of hemelytra sparsely punctate (fig. 1, C); antennae yellowish brown; apices of femora without black spots ....*C . fulvus* sp. nov.

Cresphontes fulvus sp. nov.

(Fig. 1, A-I)

FEMALE.

Head (fig. 1, A). Reddish brown and thickly punctate, distinctly wider than long; juga as long as tylus, lateral margins slightly sinuate before eyes; eyes brownish, ocelli red, space between ocellus and inner orbital margin about one-fifth the inter-ocellar space. Rostrum yellowish except the apical segments dark; segments I, II, III and IV, 0.46, 0.66, 0.38 and 0.46 mm in length respectively. Antennae yellowish brown; segments I, II, III, IV and V, 0.30, 0.40, 0.48, 0.62 and 0.70 mm in length respectively.

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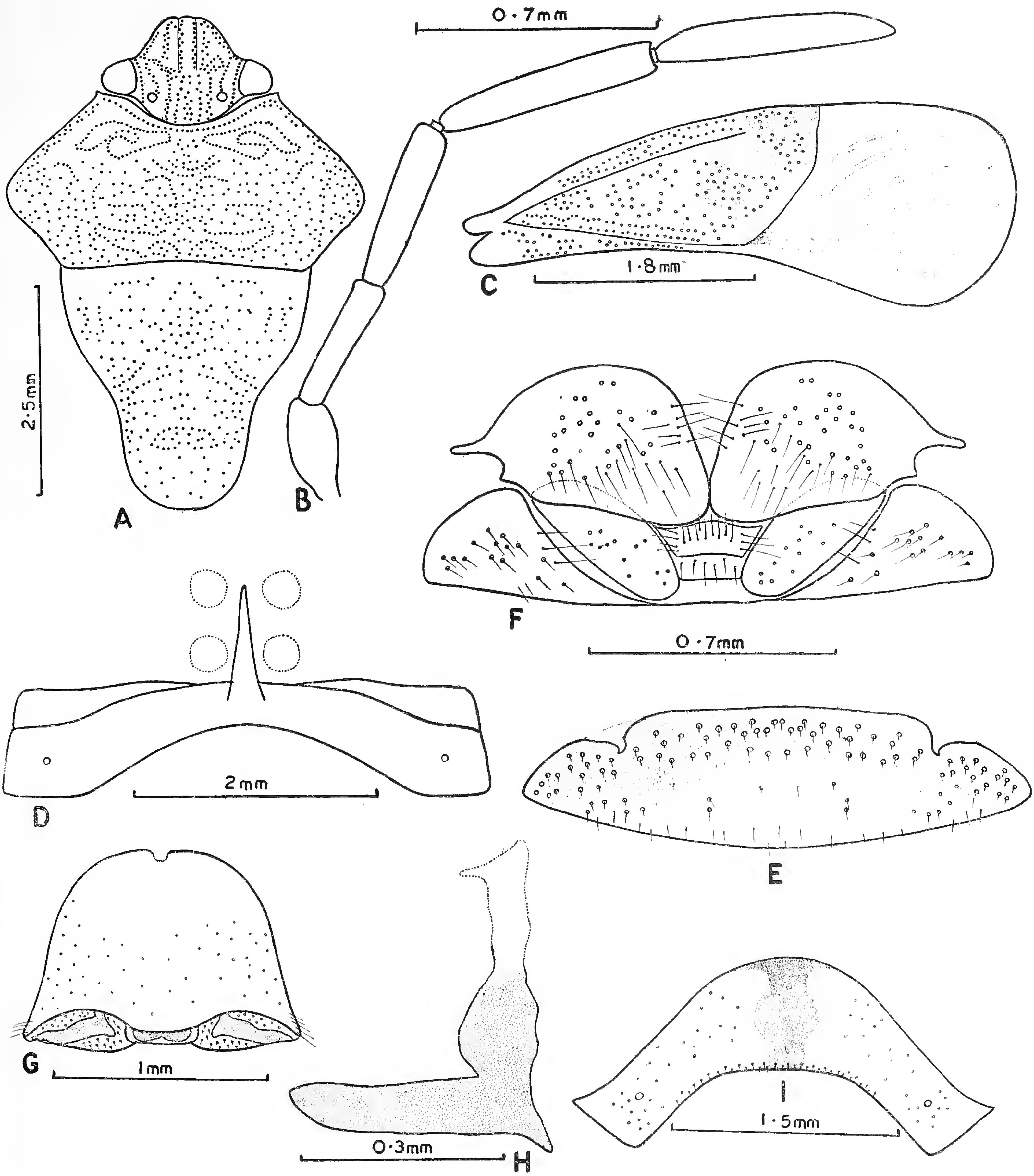

Fig. 1: A-I. *Cresphontes fulvus* sp. nov., ♀, ♂: A. Head and thorax in dorsal view, ♀; B. Antenna, ♀; C. Hemelytra, ♀; D. Abdominal spine, ♀; E. Last abdominal tergum, ♀; F. External genitalia, ♀; G. Pygophore, ♂; H. Clasper, ♂; I. Subgenital plate, ♂.

Thorax. Reddish brown with puncts uniformly and regularly arranged; pronotum anteriorly with two transverse laevigate areas, anterior margin concave with a submarginal line of puncts, anterolateral margins straight and smooth, humeral angles obtuse; maximum width of pronotum more than twice its median length; scutellum about as long as wide, apex broadly rounded; evaporatoria smooth. Hemelytra with corium sparsely punctate, ochraceous basally and reddish apically; membrane infuscated, extending beyond apex of abdomen. Legs yellowish brown.

Abdomen. Dorsum dark brown, connexiva yellowish with brown patches; venter basally with a long spine extending upto middle coxae. Female genitalia characters as in generic description and as shown in figures.

Body length. 7.5 mm.

MALE.

Resembles female. Genitalia characters as in generic description and as shown in figures.

Holotype ♀. INDIA: Uttar Pradesh, Aligarh, on inflorescence of *Mangifera indica* Linn., 5.iii.1979 (*M. Nayyar Azim*).

Paratypes 2 ♀, 2♂, on Cotton bolls, 28.iii. 1983 (*M. Nayyar Azim*), other data same as holotype.

Material deposited in the Zoological Museum, Aligarh Muslim University, Aligarh, India.

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DESCRIPTION OF A NEW SPECIES *DROSOPHILA SEPTACOILA* (DIPTERA: DROSOPHILIDAE) FROM SOUTH INDIA[1]

P. G. GAI AND N. B. KRISHNAMURTHY[2]

(*With seven text-figures*)

INTRODUCTION

South Kanara is a district located between 12.37° and 13.58°N latitude and 74.35° and 75.40° E longitude. It is essentially a forest district with heavy rainfall responsible for a variety of luxuriant flora and hence congenial for a variety of insect fauna. The forests are of evergreen and deciduous types.

Little information is available on the *Drosophila* fauna of this district, but with its congenial environment it may hold several *Drosophila* species which await discovery. This prompted us to undertake

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a collection trip to Dharmastala, a part of South Kanara, and its surrounding areas. The collections revealed rich fauna of *Drosophila* in addition to a new species *Drosophila septacoila,* a member of the *montium* subgroup which is described in this paper.

Drosophila septacoila sp. nov. (Figs. 1-7)

Body length. Male 2.02 mm, Female 2.19 mm.

Head, ♂ and ♀. Arista with 9 branches (5/4) including terminal fork. Front brown. Antenna dark brown. Carina narrow, slightly convex. Palpi yellow with 1 bristle. Orbital bristles in the ratio of 3:1:3. Inner verticals longer, outer verticals shorter than inner. Ocellar triangle small, brown, with a pair of long bristles, proclinate. Eyes red.

Thorax, ♂ and ♀. Brown. Acrostichal hairs in 8 rows, regularly placed. Ratio anterior; posterior dorsocentrals 0.5. Scutellum brown. Anterior scutellars convergent, posterior scutellars convergent and crossed. Prescutellars absent. Sterno index 0.5.

Wings, ♂ and ♀. Transluscent.

	C-index	4V-index	4C-index	5X-index	M-index
Male	1.66	0.4	0.65	2.63	0.38
Female	1.94	0.38	0.58	2.5	0.38

(Wing indices calculated after Okada 1956 and Bock 1976).

Third costal section with heavy setation on basal-male and female 0.5. Wing lengths: 1.56 mm (male) and 1.69 (female). Halteres small, pale yellowish.

Legs. Preapicals on all tibiae. Apicals on first and second tibiae. Sex comb of male (Fig. 1) longitudinal along entire length of metatarsus and second tarsal segment. Metatarsal comb consisting of 18 teeth, smaller above and longer below, the distal two displaced from axis of remaining teeth. Comb on second tarsal segment with 11 uniform teeth.

Abdomen, ♂ and ♀. Tergites of male yellow with dark apical bands. Pigmentation is broader on the mid dorsal portion of the tergites and is narrowed laterally. Abdominal pigmentation in females is similar to males except that the apical bands are slightly broader.

Periphallic organs (Figure 2). Light yellow. Epandrium round. Toe with 5 bristles. Primary and secondary surstylii present. Primary surstylus yellow, with a row of 4-5 teeth and a ventro-medial cluster of 7-9 teeth, one of which is elongated. Secondary surstylus separated from cerci, with 3 black teeth, the centre one being the longest. Secondary surstylus also bears 4 bristles on the ventro lateral margin. Cercus bears about 15 bristles in addition to 3 stumpy bristles on the ventral side.

Phallic organs (Fig. 3). Aedeagus yellow, hirsute and non-bifid. Anterior gonopophyses pointed. Posterior gonopophyses long, reach tip of aedeagus. Caudal margin of novasternum with prominent median convexity and bears a pair of spines. Novasternum bears sensilla towards the dorsal side. Basal apodeme does not project beyond ventral fragma.

Egg guide (Fig. 4). Yellow with 14 teeth and sub-terminal hair on each side.

Internal structures. Testes (Fig. 5). Yellowish with seven coils. Accessory glands large. Spermathecae (Fig. 6) large, paraovaria small, ventral receptacle long, tightly coiled. Malpighian tubules 2 pairs and free.

Egg filaments (Fig. 7). Two long slender filaments.

Pupae : Anterior spiracle with 11 branches.

Distribution. South Kanara District (Western Ghats), Karnataka, India.

Taxonomic status. The presence of egg

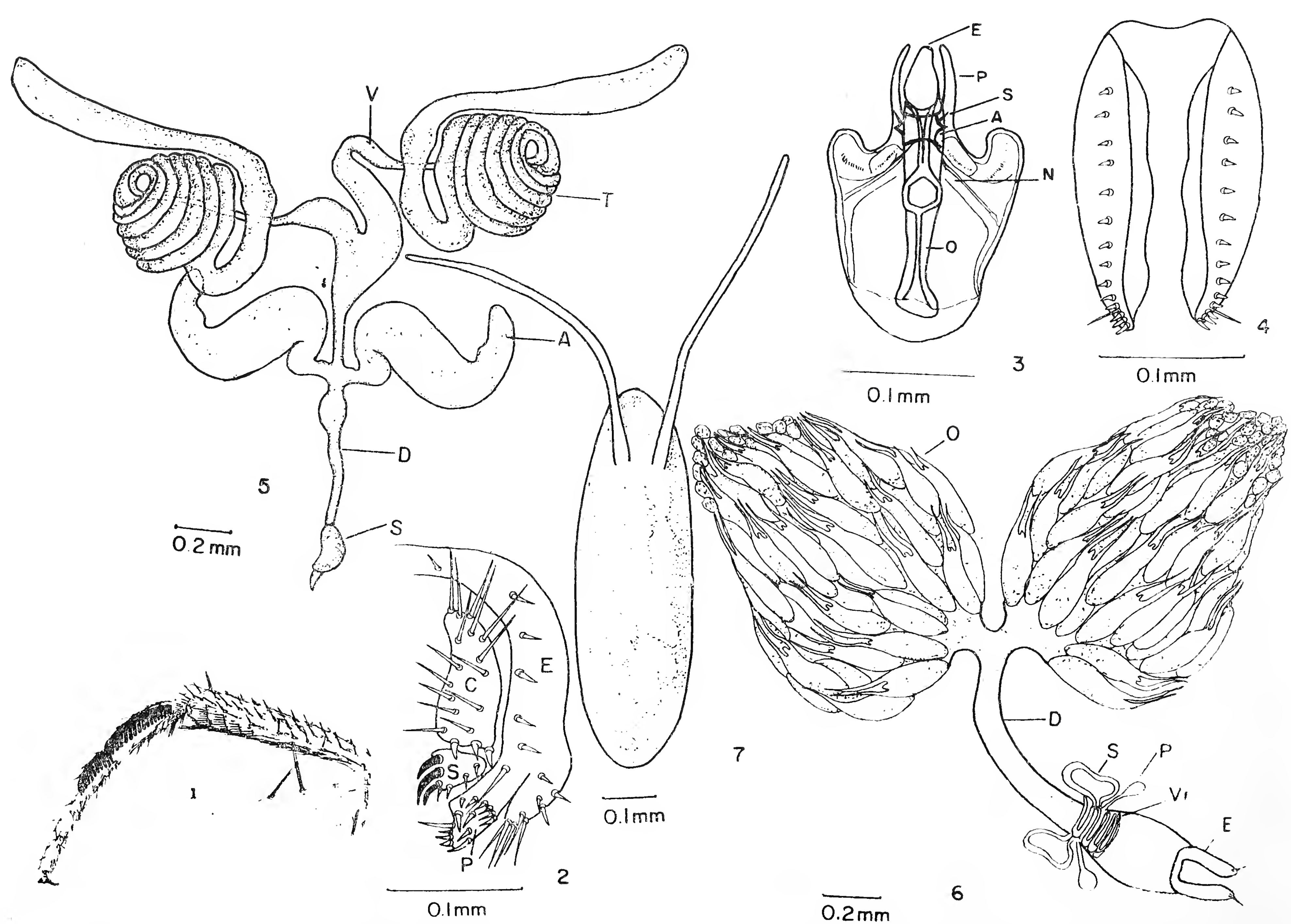

Fig. 1. Fore leg of male showing sex-comb. Fig. 2. Periphallic organs: C = Cerci, E = Epandrium, S = Secondary Surstylus, P = Primary Surstylus. Fig. 3. Phallic organs: A = Anterior gonopophyses, E = Aedeagus, N = Novasternum, O = Ejaculatory apodeme, P = Posterior gonopophyses, S = Submedian spine of novasternum, V = Ventral fragma. Fig. 4. Egg guide. Fig. 5. Male Reproductive Organs: A = Accessory glands, D = Anterior Ejaculatory Duct, S = Sperm pump, T = Testis, V = Vas deferens. Fig. 6. Female Reproductive organs: D = Oviduct, E = Vagina, O = Ovary, P = Paraovaria, S = Spermatheca, Vr = Ventral receptacle. Fig. 7. Egg.

with 2 blunt filaments, ventral receptacle that is not finely coiled, malpighian tubules free, presence of banded abdominal tergites qualify its inclusion in melanogaster species group of the Subgenus *Sophophora* (Sturtevant 1939, Patterson and Stone 1952). The presence of a large tooth bearing secondary surstylus separated from the cerci; presence of sex comb along entire length of metatarsus and second tarsal segment permits its inclusion in the *montium* subgroup (Bock and Wheeler 1972).

Relationships and Remarks.

On comparison with other members, this species shows resemblance to *D. vulcana* (Okada, pers. com.). This species resembles *D. vulcana* (Graber 1957) in gross morphological structures such as shape of the epandrium; cerci; in arrangement of teeth on primary surstylus, secondary surstylus; bristles on cerci and flattened egg filaments. However, the new species differs from *D. vulcana* with regard to the pigmentation of abdominal tergites (Shiny yellowish brown in males and shiny dark brown in females in *D. vulcana*); colour of the periphallic organ (black in *D. vulcana*); secondary surstylus completely separated from the cerci (partially separated in *D. vulcana*) and in the structure of the phallic organ. Further, the new species is characterized by having 18 teeth in the first set and 11 teeth in the second set in the sex comb, whereas *D. vulcana* has 19 teeth and 14 teeth respectively. A unique feature of this species is that the testis is made up of 7 coils whereas in the other members of the *montium* subgroup, it is usually 3 coils. This unique character along with others demands the status of a new species and hence it is named as *Drosophila septacoila* after the 7 coils of the testis.

Holotype ♂. INDIA. Karnataka, South Kanara District (Western Ghats) 4.x.82. Coll. P. G. Gai, N. B. Krishnamurthy and S. N. Hegde. Deposited in the museum of the Department of Zoology, University of Mysore, Manasagangotri, Mysore.

Paratypes. 5♂♂ and 5♀♀ (data same as above) 4 ♂♂ and 3 ♀♀ deposited in the Department of Biology, Tokyo Metropolitan University, Setagaya-ku, Tokyo, Japan.

ACKNOWLEDGEMENTS

We are grateful to Prof. T. Okada, (Emeritus Scientist), 2-30-18, Setagaya-ku, Tokyo, Japan for his help in confirming the identity of the species. One of us (P.G.G.) is thankful to the University of Mysore and the U.G.C. for award of a Teacher-Fellowship under F.I.P., and also to the authorities of Vijaya College, Bangalore for the study leave. We also thank Dr. S. N. Hegde and Dr. V. Vasudev for their helpful discussions.

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A NEW SPECIES OF *OSBECKIA* L. (MELASTOMATACEAE) FROM KERALA (INDIA)[1]

G. S. GIRI AND M. P. NAYAR[2]

(*With a text-figure*)

A new species of *Osbeckia* L., *O. abrahamii* sp. nov. is described here with illustrations. A diagnostic key is also provided for easy identification.

Osbeckia abrahamii sp. nov.

Affinis *O. asperae,* sed caulibus crassibus, fistulosis, folius dense pubescento-setosibus, calycis tubis dense stellato-excrescentibus, calycis lobis asymmetricalibus, bracteis orbicularibus differt.

Erect, unbranched or rarely branched herb, upto 1 m tall; stem terete, thick more or less fleshy, hollow, covered with short, rigid hairs, hairs at nodes sometimes larger. Leaves simple, opposite, elliptic or elliptic-lanceolate (3.0-) 4.5 — 6.5 (-8.0) × (1.2-) 1.5 — 2.5 (-2.8) cm, base acute to cuneate, apex acute to shortly acuminate, margin entire, main nerves (3-) 5 — 7, all arising from the base, cross nervules inconspicuous above, prominent beneath; both surfaces covered with short, stiff, subappressed to ascending hairs, hairs on the nerves beneath usually longer, bristly and often appear in groups, becomes dull green to brownish on drying, chartaceous; petioles (3-) 5 — 9 (-12) mm long, appressed hairy. Inflorescence axillary or terminal, few flowered short panicle, bracts orbicular, broader than long 2.0 — 4.0 × 3.5 — 5.5 mm, appressed hairy above, glabrous beneath, sometimes series of bracts remain persistent on the peduncle. Flowers bisexual, 5-merous, sessile or with a very short pedicel of about 1 mm long. Calyx-tube broadly urceolate, (4.0-) 5.0 — 7.0 (-8.0) × (3.0) 3.5 — 5.5 (-7.0) cm, densely covered with flat, stellate or very slightly stalked emergences, often intermixed with bristles, hairs on the emergences arise with a downward fashion, brownish. Calyx-lobes 5, distinctly asymmetrical, truncate, broader than long, 2.0 — 3.5 × 2.5 — 4.2 mm, unequally two lobed at apex, midrib distinct, patent hairs and emergences occur on the midrib dorsally, otherwise glabrous, long ciliated at margin, deciduous. Intersepalar emergences with a terete stalk and stellate head and tuft of bristles, deciduous. Petals 5, obovate, 16.0 — 20.0 × 12.0 — 14.0 mm, ciliated at margin, pink or purple in colour. Stamens 10, equal, filaments 6.0 — 8.0 mm long, glabrous; anthers twisted, 6.0 — 7.5 mm long, including a small narrow beak, pore apical, large, connective produced into a small indistinctly lobed collar. Ovary 5.0 — 7.0 mm long, nearly $^1/_3$ adnate to the calyx-tube, free apical part densely covered with brownish appressed hairs, true crown of bristles absent; style 16-19 mm long, glabrous, curved, swollen below the punctate stigma. Capsules 7.0 — 9.0 × 4.5 — 5.5 (-7.0) mm, broadly urceolate, free portion of the capsules slightly exposed or remain enclosed by the calyx-tube. Seeds small, muricate.

Type. Travancore, Kerala, *Narayanaswami* 1379 (Holotype, CAL).

Flowering time. Aug. — Oct.

Fruiting time. Sept. — Dec.

[1] Accepted September 1983.

[2] Botanical Survey of India, Howrah-711 103.

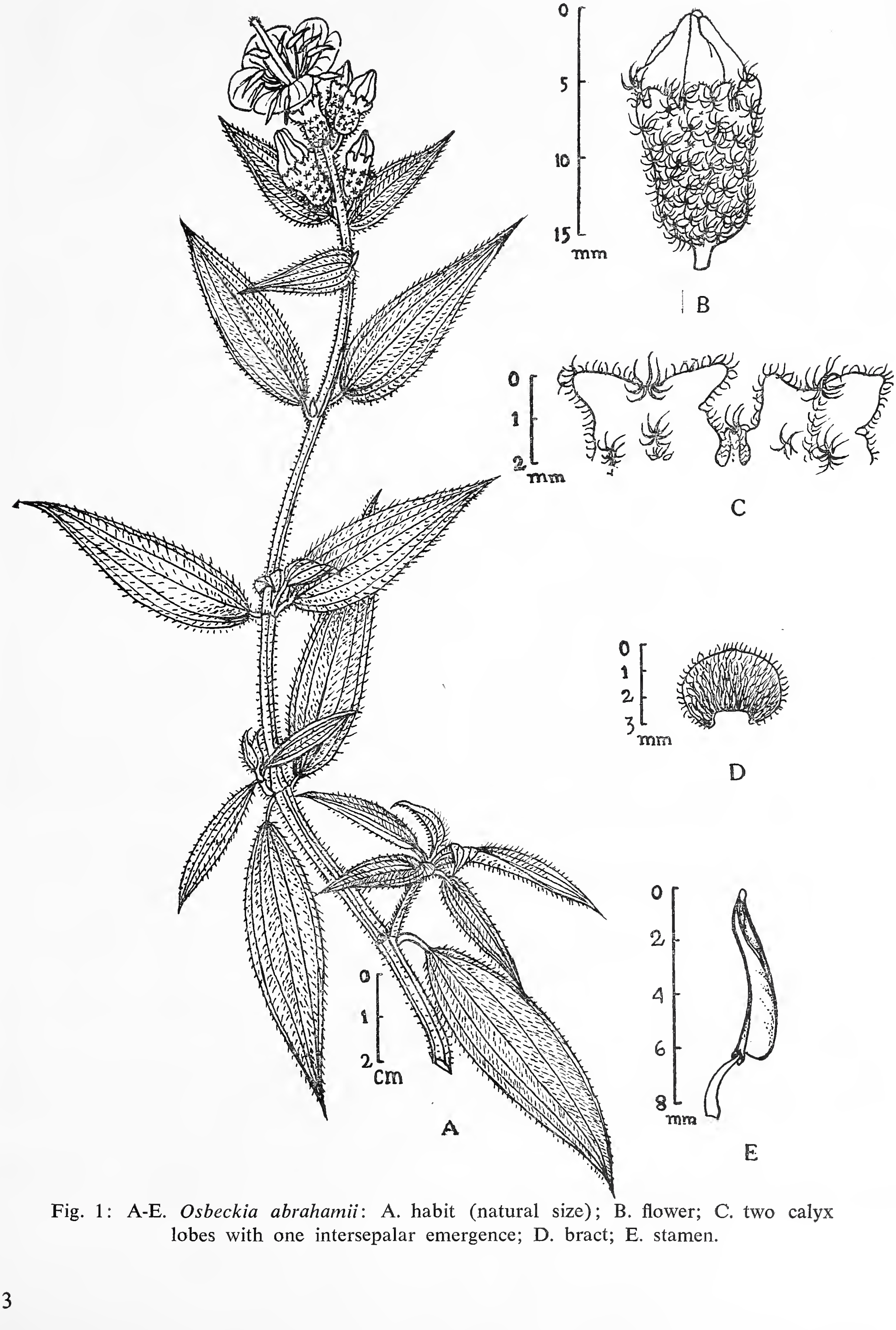

Fig. 1: A-E. *Osbeckia abrahamii*: A. habit (natural size); B. flower; C. two calyx lobes with one intersepalar emergence; D. bract; E. stamen.

Distribution. India. Kerala.

Travancore, *Narayanaswami* 1707; Silent Valley, Palghat Dist., 875 m. 11.10.1965; *Vajravelu* 26161; *Koni,* Travancore, *Rama Rao* 536; Trichur, Tumbermughi, 75 m, 12.9. 1976, *Ramamurthy* 48476.

This species is related to *O. aspera* (L.) Blume, but can be easily distinguished by the calyx-tube being densely clothed with stellate emergences, orbicular bracts, asymmetrical calyx-lobes, thick, hollow stems and setose pubescent leaves; whereas in *O. aspera,* calyx-tube is sparsely covered with patent hairs or bristles and without emergences, bracts elliptic with acute or sharply pointed apex, calyx-lobes symmetrical and the stems slender with sparsely pubescent leaves.

O. travancorica Bedd. *ex* Gamble was reduced to a variety under *O. aspera* by Hansen (1977), where he remarked that the variety is distinguished by the asymmetrical calyx-lobes and curved, strong, prickly bristles on the stem. But *O. travancorica* Bedd. *ex* Gamble is a different species. On examining the type, verifying the protologue and drawing by Gamble on the type material (*Wight* 1100), it is seen that, the stem is distinctly covered with downwardly curved, strong, prickly bristles; calyx-lobes not asymmetrical, rather broadly triangular with obtuse or slightly emarginate apex. Whereas in *O. abrahamii,* the stem is covered with very short, rigid and appressed hairs, calyx-lobes broader than long, truncate and typically asymmetrical.

A diagnostic key is given below for easy identification :

A. Stem and banches covered with short, rigid appressed hairs

B. Calyx-lobes symmetrical, broadly triangular with acute, obtuse or slightly emarginate apex; bracts elliptic with acute or sharply pointed apex; calyx-tubes sparsely covered with bristles and simple hairs, emergences usually absent or if rarely present are restricted to the top; leaves sparsely pubescent; stem slender. . . . . *O. aspera*

BB. Calyx-lobes asymmetrical, broader than long, truncate, unequally lobed; bracts orbicular; calyx-tube densely covered with stellate emergences; leaves much pubescent; stem thick and hollow. . . . . . . *O. abrahamii* sp. nov.

AA. Stem and branches densely covered with strong, downwardly curved, prickly bristles . . . . *O. travancorica*

The species is named after Prof. A. Abraham, formerly Professor of Botany, University of Kerala and at present, Director of Botanic Gardens, Trivandrum, for his contributions to the systematics of the Orchid and Ferns flora of peninsular India.

OSBECKIA ARUNKUMARENSIS SP. NOV. FROM EASTERN INDIA[1]

M. P. Nayar and G. S. Giri[2]

(*With two text-figures*)

New species of *Osbeckia* L., *O. arunkumarensis* sp. nov. is described from Eastern India with illustrations. A diagnostic Key is also given for identification.

Osbeckia arunkumarensis sp. nov.

Affinis *O. stellatae* Ham. ex Ker. — Gawl., sed ramis conspicue quadrangularibus alatisque, foliis subsessilibus, calycis tubo glabro, capsulo apice nonquam setoso differt.

Annual, erect, unbranched or rarely branched herb, up to 1.5 m high; stems and bran-

[1] Accepted July 1983.

[2] Botanical Survey of India, Howrah-711 103.

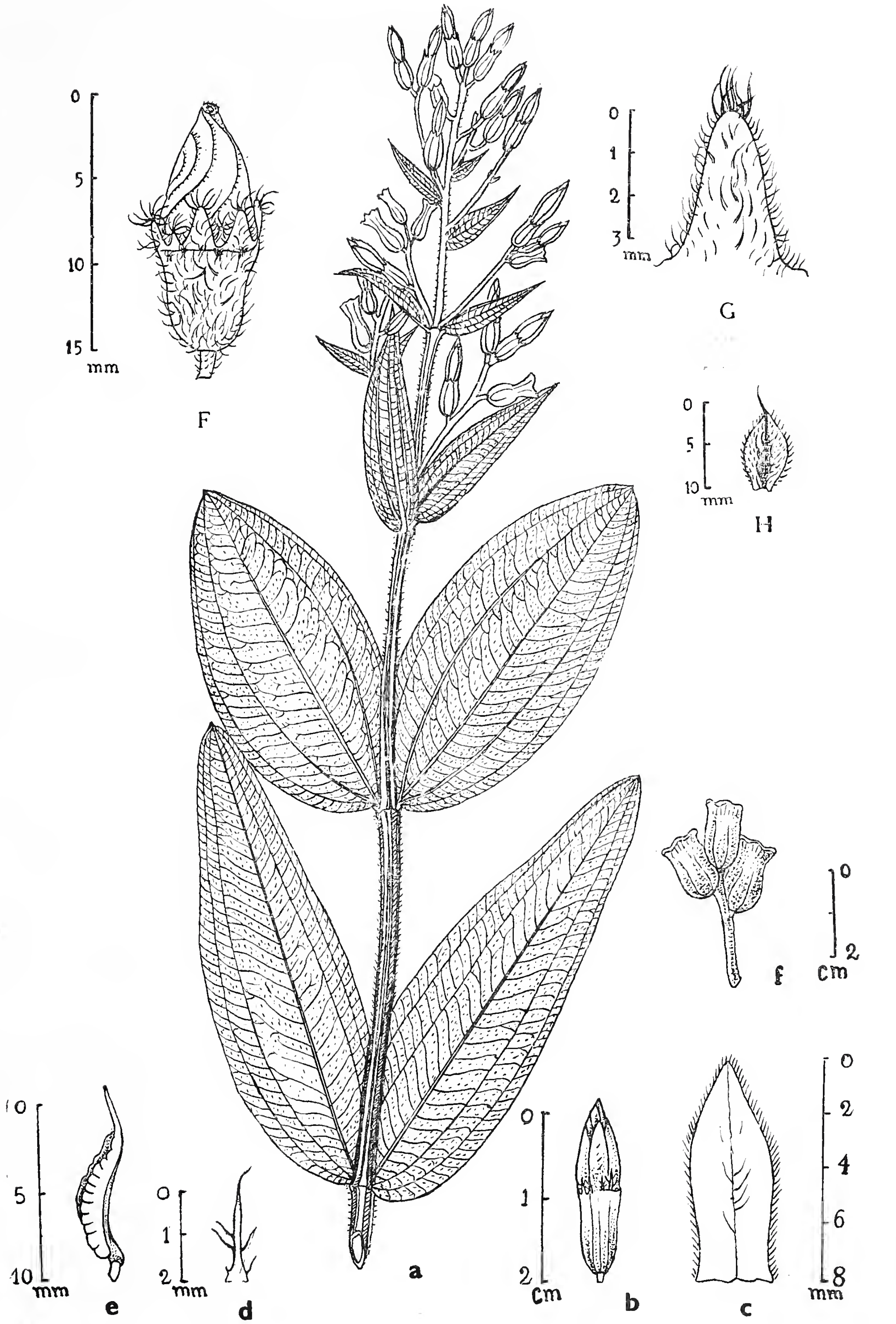

Fig. 1. a-f: *Osbeckia arunkumarensis* sp. nov. a. habit (natural size); b. flower; c. sepal; d. intersepalar emergence; e. anther; f. part of infructescence.
Fig. 2. F-H: *O. stellata* Ham. *ex* Ker.-Gawl.: F. flower; G. single calyx-lobe; H. bract.

ches strongly quadrangular and distinctly winged; densely covered with short rigid appressed or subappressed hairs, hairs on the wing usually longer, older part sometimes become glabrate. Leaves simple, opposite, subsessile, thinly coriaceous, ovate to ovate-elliptic or rarely ovate-oblong (6-) 8 — 14 (-21) × (2.5) 3 — 4 (-7) cm, base subrounded to subcordate, apex acute to shortly acuminate, margin setosely ciliate, recurved or not, 5—7 nerved, cross-nervules arising from the midrib with somewhat a curved nature, other nervules more or less straight and parallel, nerves and nervules impressed above, raised beneath, upper surface sparsely to densely appressed hairy, hairs short, rigid, lower surface sparsely hairy but long appressed hairs occur on nerves and nervules of lower surface, upper surface turns dull green to black and lower surface becomes brown on drying; petioles (0.5-) 2 — 3.5 (-5) mm long, appressed hairy. Inflorescence axillary or terminal, usually a many flowered, lax, cymose panicle, bracts broadly ovate, 2.5 — 4.5 × 2 — 4 mm, ciliated at margin, dorsally glabrous or with few patent hairs. Flowers bisexual, 4-merous, sessile. Calyx-tube urceolate, 7 — 8 × 3.0 — 3.5 mm, adnate to the ovary, glabrous, usually with longitudinal striations. Sepals 4, oblong, acute, 5.5 — 8.0 × 2.5 — 4.0 mm, midrib distinct, long ciliated at margin, few to many patent hairs occur on dorsal surface, particularly on the midrib, otherwise glabrous, deciduous. Intersepalar emergences with a distinct stalk of 2 — 4 mm, terminated by a bristle and not with a stellate head, few patent hairs occur on the stalk at the base or near the middle, deciduous. Petals 4, bright mauve or dark to light violet, obovate, 16 — 18 × 10 — 14 mm, finely ciliated at margin. Stamens 8, equal; filaments filiform, 6 — 9 mm long, glabrous, anthers 'S' shaped, 6 — 9 mm long including a narrow beak, pore small, oblique on the ventral side at the tip, connective extended into a small collar, collar more or less trilobed, lateral lobes not prominent, anthers not twisted. Ovary nearly $\frac{1}{2}$ adnate to the calyx-tube, free portion glabrous or sparsely hairy on the upperpart, anther pockets extending nearly to the base of the ovary, ovary glabrous at the top or sometimes with few soft hairs forming an indistinct crown, the hairs deciduous; 4-loculed, placentation axile; style slender, 16 — 20 mm long, glabrous, slightly swollen below the punctate stigma. Capsules up to 8 mm long, without a crown of bristles at the apex; calyx tube in fruiting condition with a long neck, 12 — 15 (-18) × 5 — 7.5 mm, glabrous, whitish with minute black spots. Seeds minute, muricate.

TYPE. Sikkim, East Himalaya, *Griffith* Kew Distrib. No. 2248 (Holotype CAL; K).

DISTRIBUTION: INDIA: *Assam*: Matharguri to Jongram Route, July 12, 1957, *R. S. Rao* 10022; Between Dudhnai and Rangguli, Goalpara Dist., June 25, 1964, *R. S. Rao* 39113.

Meghalaya: Shillong, 4500 ft. (1368m), August 18, 1885, *C. B. Clarke* 38896E; Khasia, *G. Mann* s.n. (CAL 171971).

Sikkim: Sikkim Himalaya, 1875, *G. King s.n.*

Bengal: N. Bengal, Sikkim Terai, 9.68, *S. Kurz s.n.* (CAL 172004), without precise locality, Sine Coll., s.n. (CAL 171981).

NEPAL. Napalia inferior, 1882.

[*Osbeckia campestris* Ham. *in* Wall., Num. Dist. No. 4063, (nom. nud.)]

The species is allied to *O. stellata* Ham. *ex* Ker.-Gawl., but can be easily distinguished by the following key :

1a. Branches not winged; leaves distinctly petiolate; calyx-tube sparsely to densely covered with stellate or glandular emergences and simple hairs; intersepalar emergences usually with a

stellate head; capsules with a distinct crown of bristles at the apex.................*O. stellata*

1b. Branches distinctly winged; leaves subsessile; calyx-tube glabrous; intersepalar emergences terminated by a bristle, stellate head absent; capsules without a crown of bristles at the apex. ....*O. arunkumarensis* sp. nov.

Note. Hansen (Ginkgoana, 4 : 28. 1977), merged the following taxa and kept them as synonym under *O. stellata* var. *rostrata* (D. Don) Hansen. These are : *O. campestris* Ham. *ex* Wall., Num. List. Pl. 143, No. 4063. 1831 (*nom. nud.*) — *O. nulchella* Benth. *ex* Wall., Num. List. Pl. 143, No. 4059 (*nom. nud.*) — *Ceramicalyx pulchellus* Blume, Mus. Bot. Lugduno — Batavum 1 : 50. 1849 (Type material : Wallich 4059 B) — *O. rostrata* var. *pulchella* Triana, Trans. Linn. Soc. London 29 :54. 1972 (*nom. nud.*)

We had the opportunity to examine all the types for the plants referred to above. A critical study support Hansen (1977) in his reduction of *O. pulchella* Benth. *ex* Wall. Num. List. Pl. 143, No. 4059. 1831 (*nom. nud.*) and *C. pulchellus* Blume, Wallich 4059B to *O. stellata* var. *rostrata* (D. Don.) Hansen. But *O. campestris* Ham. *ex* Wall., Num. List Pl. 143, No. 4063. 1831 (*nom. nud.*) is specifically distinct and can be easily distinguished as mentioned earlier.

This beautiful species is named in honour of Professor Arun Kumar Sharma, University of Calcutta, for the contribution he has made in the field of cyto-taxonomic studies of Indian plants.

NEW SPECIES OF *PSYCHOTRIA* (RUBIACEAE) FROM INDIAN SUBCONTINENT[1]

D. B. Deb and M. Gangopadhyay[2]

(*With three text-figures*)

Three new species of *Psychotria* (Rubiaceae) from the Oriental Region namely, *Psychotria burmanica* sp. nov., *P. meeboldii* sp. nov., and *P. russellii* sp. nov. are described with illustrations.

Three of the novelties discovered in the course of taxonomic revision of *Psychotria* for the revised *Flora of India* are described below:

1. **Psychotria burmanica** sp. nov. (Fig.1)

differt a *P. symplocifolia* Kurz habitu parva-arbore, foliis magnis, stipulis oblongis, obtusis, corollis fauce confertim lanuginosis fructibusque angustioris inter alia.

Type. Burma, Tavoy, Head waters of Sedi chung, 3000 ft. (900 m), 15.5.1920, *P. T. Russell* 1806 (in flower) A — holotype CAL, B — isotype CAL; Head waters of Sedi chung, 3000 ft (900 m), 1.6.1920, *P. T. Russell* 1832 (A,B,C in fruit, D. sterile — paratypes) CAL; Heinze no. 1 camp, 1700 ft (510 m), 18.4.1921, *P. T. Russell* 2027 A,B,C (in flower) paratypes CAL.

Trees small. Branchlets quadrangular when young, glabrous, striated, 0.3 — 1 cm in diam. *Leaves* 15 — 27 × 3 — 6 cm, petiolate, obovate or oblanceolate, acuminate, prominently incurved at margin, attenuate, coriaceous, glabrous, green to olive-green when dry; midrib stout, lateral nerves 10 — 16 on either side, subopposite, slender, arcuate, bacterial glands

[1] Accepted October 1983.

[2] Botanical Survey of India, Howrah-711 103.

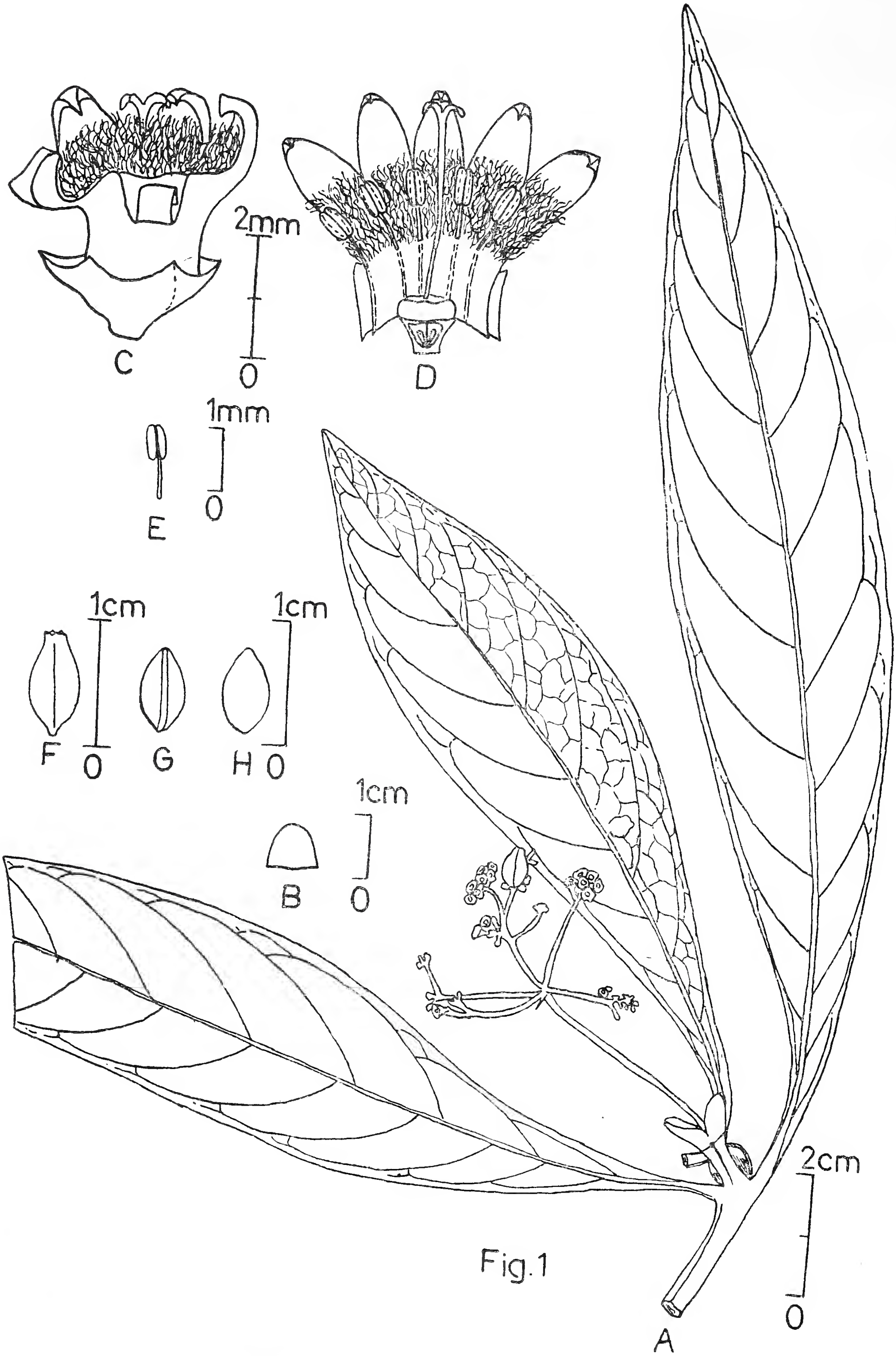

Fig. 1. *Psychotria burmanica* sp. nov. A. Habit, B. Stipules, C. Flower, D. Opened flower, E. Stamen (dorsal view), F. Fruit, G. Seed (dorsal view), H. Seed (ventral view).

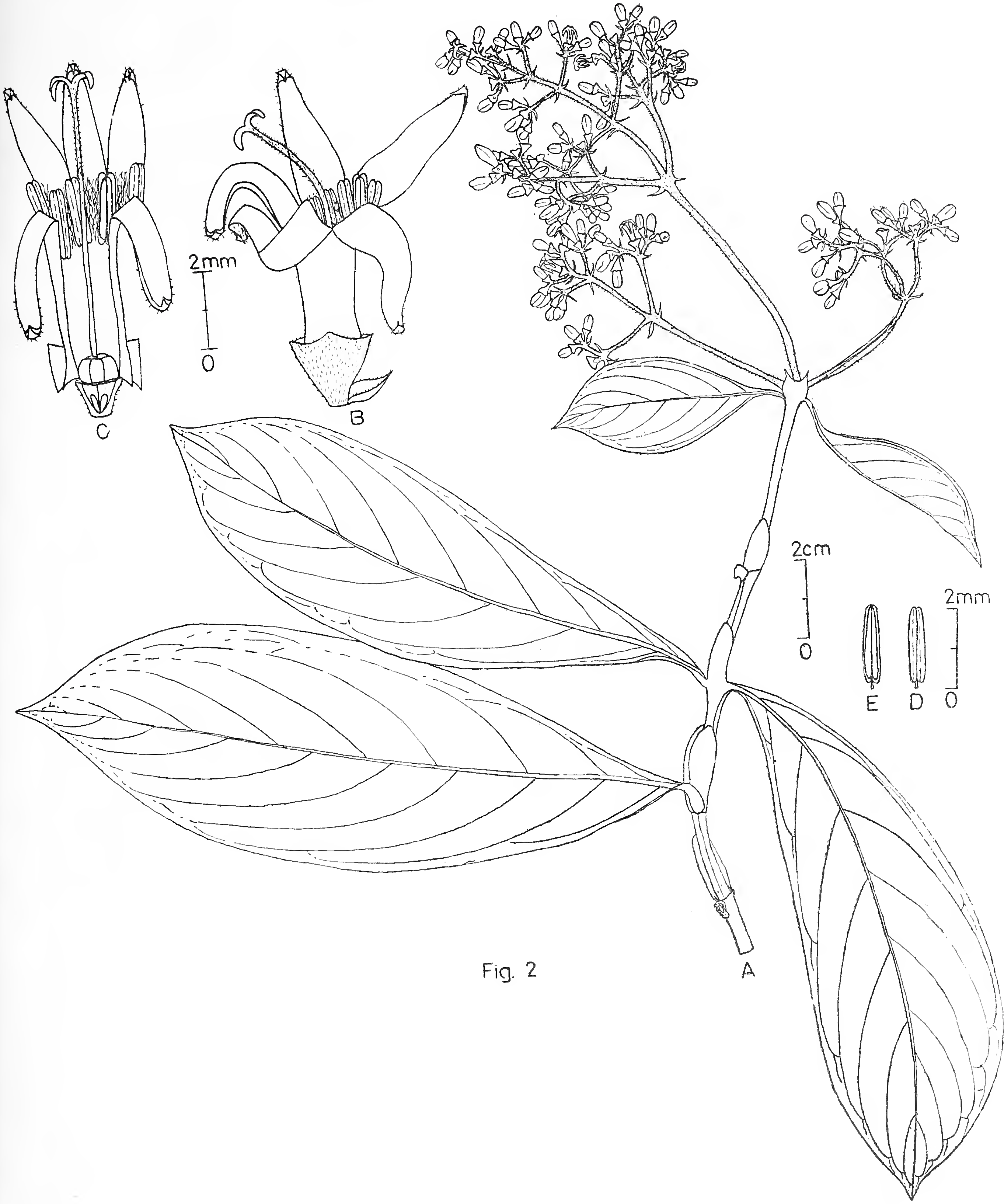

Fig. 2. *Psychotria meeboldii* sp. nov. A. Habit, B. Flower, C. Opened flower, D. Stamen (ventral view), E. Stamen (dorsal view).

sometimes perforate the axil; nervules reticulate, petioles 1 — 3.5 cm, stout terete; stipules 4 — 6 × 5 — 6 mm, oblong, obtuse or retuse, coriaceous, glabrous above, ferruginous villous beneath. *Inflorescence* peduncled, terminal corymbose heads, 2 — 7 × 2 — 3.5 cm, branches 4 or 5, verticillate, branchlets short, terminating in heads; peduncles 1 — 3.5 cm, glabrous or puberulous; bracteoles 1 — 2 × 2 —3 mm, ovate or triangular, acute, entire or toothed, glabrous above, puberulous at the base beneath. *Flowers* 4 — 5 × 3 — 4 mm, sessile. *Hypanthium* about 0.5 mm long, glabrous. *Calyx* persistent, about 1 × 2 — 3 mm, cupular, with short triangular teeth, glabrous. *Corolla* tube about 2 mm long, thin, glabrous above, densely woolly at the throat, conspicuously veined; lobes 5, 1.5 — 2 mm long, ovate, inflexed, glabrous. *Stamens* 5, inserted at the throat; filaments ± 0.5 mm long, narrow, adnate just below the throat, alternating with the corolla lobes; anthers ± 0.5 mm long, oblong, dorsifixed, dehiscent through the longitudinal slits. *Ovary* ± 0.5 mm, 2 celled, each with a solitary ovule; style ± 3 mm long, narrow, glabrous; stigma capitate, 2 lobed, papillose; disc annular, 0.5 — 1 mm across. *Fruits* sessile, ± 8 × 4 mm, ellipsoid, crowned with persistent calyx; pyrenes 2, thin walled with raphides, dorsally one ribbed. *Seeds* ± 6 × 3 mm, ellipsoid, acute at both ends, thin, dorsally solitary ribbed, ventrally flat; albumen uniform.

Flowering time. April — May.

Fruiting time. June — ?

Distribution. Burma, Tavoy.

2. **Psychotria meeboldii** sp. nov. (Fig. 2)

differt a *P. flavida* Talb. foliorum nervis lateralibus numero minoribus, floribus majoribus, calycibus pubescentibus, bracteolatis corollarum lobis puberulis, antheris majoribus, stylisque puberulis.

Type. Ceylon (Sri Lanka), Colombo, March 1905, *A. Meebold* 2323 (holotype) CAL.

Shrubs branching; branchlets 3 — 5 cm thick, compressed, glabrous. *Leaves* 14 — 17 × 4.5 — 5.5 cm, petiolate, obovate, acuminate, tapering towards the base, coriaceous, glabrous, pale green when dry; midrib prominent on both surfaces; lateral nerves 7 — 9 on either side, subopposite, inconspicuous above, arched towards the margin, with bacterial gland opening by a pore at the axil; nervules reticulate; petioles 5 — 8 mm, glabrous; stipules persistent, 5 — 6 × 15 — 18 mm, ovate-oblong, acute to acuminate, entire, connate at the base, membranous, glabrous above, loose ferruginous pubescent at the base beneath. *Inflorescence* terminal panicle of cymes, ± 13 × 11 cm, trichotomously branching, slender, puberulous; peduncle ± 5 cm long, slender, glabrous; bracts 2, foliaceous, 5 — 6 × 2.5 cm, obovate, acuminate, entire, cuneate, coriaceous, glabrous, pale green. *Flowers* in cymes, lax, middle one sessile, laterals pedicellate, 9 — 10 mm long, tubular, bracteolate; bracteoles 1 — 5 × 0.7 — 2 mm, ovate or lanceolate, caudate acuminate, entire or irregularly toothed, glabrous, puberulous at margin; pedicel 1 — 1.5 mm long, puberulous. *Hypanthium* about 1 mm long, puberulous above. *Calyx* cupular, 1 — 1.5 × 3 — 4 mm, minutely toothed, puberulous above, glabrous beneath, with a bracteole just below the calyx-tube. *Corolla* tube 3—4 mm long, puberulous above, gradually glabrous, throat woolly beneath; lobes 5, reflexed, 4 — 4.5 mm long, oblong, thick, keeled at the apex, puberulous above, glabrous beneath. *Stamens* 5, inserted; filament minute, adnate just below throat; anther ± 2 mm long; dorsifixed, linear-oblong, dehiscing longitudinally. *Ovary* two celled, with solitary ovule in each cell,

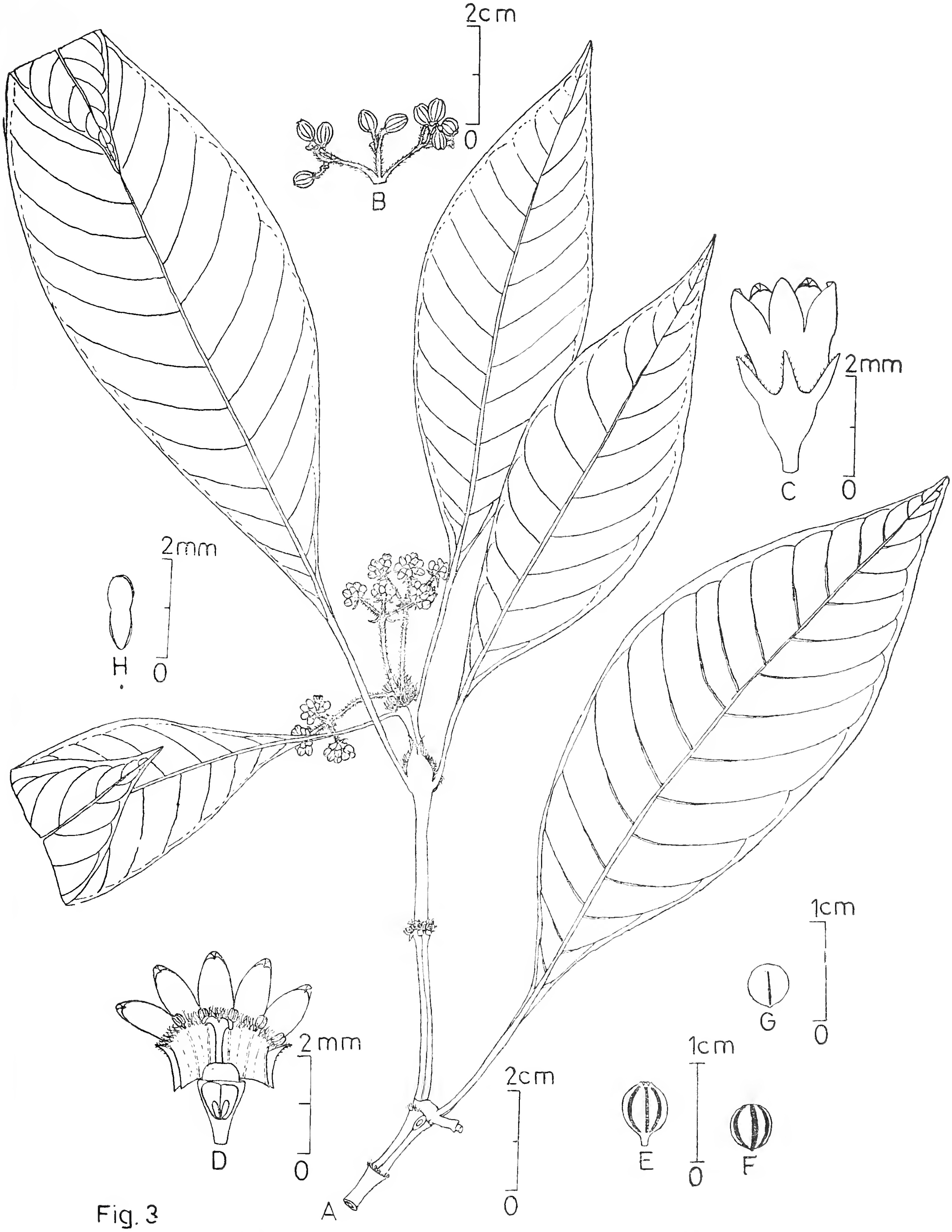

Fig. 3. *Psychotria russellii* sp. nov. A. Habit, B. Inflorescence, C. Flower, D. Opened flower, E. Fruit, F. Seed (dorsal view), G. Seed (ventral view), H. Embryo.

basally attached; rephides present in the ovary and disc; style 5 — 7 mm long, gradually widening towards the apex, densely puberulous above, glabrous below; stigma 2 lobed, 1—1.5 mm long, oblong, obtuse, puberulous; disc subglobose, ribbed, grooved, 0.5 mm in diam.

Flowering time. March.

Distribution. Sri Lanka.

3. **Psychotria russellii** sp. nov. (Fig. 3) differt a *P. monticola* Kurz foliis angustis ellipsoideis vel obovatis, capitulis angustioribus sed numero amplis, fructibusque globosis angustioribus.

Type. Burma, Tavoy, Heinze no. 1 camp, 1700 ft (510 m), 5.4.1921, *P. T. Russell* 1943 (in flower) A — holotype, B — isotype, CAL; ibid., 23.11.1921, *P. T. Russell* 2186 (in flower) paratype CAL; ibid., 28.4.1821, *P. T. Russell* 2077 (in flower) paratype, CAL; Tenasserim, March 1911, *A. Meebold* 14700 (in fruit) paratype CAL.

Shrubs branching; branchlets glabrous, smooth, 0.2 — 1 cm in diam., quadrangular when young. *Leaves* petiolate, slightly unequal in pair, 9 — 21 × 2 — 6 cm, elliptic or obovate, acuminate at the apex, slightly incurved, cuneate at the base, thin coriaceous, glabrous, punctate, green when dry; midrib slender, channelled above, lateral nerves 7 — 14 on either side, subopposite, subparallel, arcuate, slender, axil imperforate, nervules reticulate, inconspicuous; petioles 2 — 4.5 cm long, slender, glabrous; stipules 7 — 10 × 4 — 6 mm, ovate, two lobed, long acuminate, sometimes each lobe again divided into two irregular lobes, glabrous or densely irregularly ferruginous tomentose above, dense almost covering ferruginous tomentose sheath of hairs (colleters ?) beneath. *Inflorescence* terminal, trichotomous, umbellate heads; peduncles very short, ± 5 mm long, tomentose, branches and branchlets slender, tomentose; bracts deciduous, 4 — 6 × 1 — 3 mm, linear-lanceolate entire or irregularly shortly lobed, tomentose; bracteoles 2 — 4 × 1 — 2 mm, linear-lanceolate, entire or irregularly lobed at the base, tomentose beneath; heads 4 — 6 mm across. *Flowers* short tubular, subsessile; pedicel 0.5 mm long, glabrous. *Hypanthium* ± 0.5 mm, obovate, smooth. *Calyx* 1 — 1.5 × 2 — 2.5 mm; tube short, glabrous; lobes 5, ovate-lanceolate, ciliate at the margin. *Corolla* tube ± 1 mm long, glabrous above, loose villous at the throat beneath. *Stamens* 5, inserted; filament short, adnate to the throat, alternating with the petals; anther ± 0.5 mm, dorsifixed. *Ovary* two celled; style ± 1.5 mm long, stout; stigma capitate, 2 lobed, glabrous; disc subglobose, smooth. *Fruit* 4 — 5 × 4 — 4.5 mm, globose or ovoid, very short stalked, crowned with persistent calyx lobes, 6 ribbed and grooved; pericarp warty, thick. *Pyrenes* 2, ovoid, obtuse at the apex, acute at the base, plano-convex, dorsally 3 ribbed and 4 grooved, wall thin, with raphides. *Seeds* 4 — 4.5 × 4 mm, plano-convex, obtuse at the apex, shortly stalked at the base, dorsally 3 ribbed and 4 shallow grooved, ventrally flat with a shallow longitudinal furrow; albumen ruminated; embryo 1 — 1.5 mm long; axis 0.5 — 1 mm long, blunt at base, two side with shallow channel forming a wing like projection; cotyledons 2, 0.5 — 1 mm long, oblong, obtuse at the apex, thin, inconspicuously veined, radicle inferior.

Flowering time. March — April.

Fruiting time. November.

Distribution. Burma: Tavoy and Tenasserim.

Note. The specimens were tentatively determined as new by the collector P. T. Russell. The species is now named after him.

ACKNOWLEDGEMENT

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DESCRIPTIVE NOTES ON THREE NEW OR RARE HIMALAYAN TAXA OF *INDIGOFERA* L. (FABACEAE — PAPILIONOIDEAE)[1]

M. SANJAPPA[2]

(*With two text-figures*)

(i) Some specimens of *Indigofera* collected by C. B. Clarke from Khasia Hills (Meghalaya) were named by him as *I. sesquipedalis* and noted its resemblance with 'Khasia heteranth' (i.e. *I. heterantha* Wall. ex Brandis of Khasia). However, several other sheets which resemble *I. sesquipedalis* were found to be erroneously identified by him as *I. dosua* Ham. (*C. B. Clarke* 7296), *I. heterantha* Wall. ex Brandis (*C. B. Clarke* 18598), *I. leptostachya* DC.? (*C. B. Clarke* 40103), and *I. pulchella* Roxb. (*C. B. Clarke* 18614).

D. Prain on examination of all the above specimens at CAL has annotated them as '*I. sesquipedalis* C. B. Clarke *Mss.*' Indeed, on critical study of all the above sheets and many other specimens from different herbaria, they were found to represent a distinct species which is allied to *I. heterantha* as was suspected earlier by C. B. Clarke. Since, this species had not been published by Clarke or by others, it is described here in detail with illustrations:

Indigofera sesquipedalis C. B. Clarke ex Sanjappa, sp. nov.

I. heterantha Wall. ex Brandis, affinis sed differt habitu parniore (usque ad 1 m), ramisque blabrescentibus, foliis manifeste petiolatis, sacemis pedunculatis, antheris sparsim barbatis, leguminibusque brevioribus, deflexis, patentibus.

Holotypus lectus a *C. B. Clarke* 38232 and locum Shillong, alt. 5000 ped., die 1.6.1885, et positus in CAL.

[1] Accepted May 1982.

[2] Botanical Survey of India, Howrah 711 103.

Indigofera sesquipedalis C. B. Clarke ex Sanjappa, sp. nov. (Fig. 1)

Allied to *I. heterantha* Wall. ex Brandis but differs from it in being a small shrub (up to 1 m), and having glabrescent branches, distinctly petiolate leaves, peduncled racemes, sparsely bearded anthers and shorter deflexed spreading legumes.

Type: Shillong, 5000′ 1 Jun. 1885, *C. B. Clarke* 38232 (holotype, CAL).

Undershrub *c.* 60 cm high, copiously branched from the base, branches 15-35 cm long, angular adpressed pubescent when young, terete and glabrous at maturity, root stock thick. Leaves 2.5-3 cm long, pinnate, alternate, petiole 6-10 mm long, canaliculate above, adpressed pubescent; leaflects (5-) 7-11 (17), opposite, 5-7 × 2-3 mm, tiny, oblong or obovate, rounded to obtuse at base, obtuse at apex, mucronate, glabrescent and green above, adpressed pubescent and pale below; stipules 1-1.5 mm long, subulate, adpressed pubescent without; stipels *c.* 1 mm long, setaceous; petiolules *c.* 1 mm long, pubescent. Racemes 2.5-3 cm long, axillary, many-flowered, compact, peduncles 5 mm long, angular, adpressed pubescent. Flowers rose-purple or deep crimson-purple; bracts 1.2-2 mm long, setaceous adpressed pubescent without; pedicels *c.* 1 mm long; calyx 2 mm long, campanulate, lobes 1.5 mm long, subulate, adpressed pubescent without, tube 0.5 mm long; standard 3.5-4 × 2.5 mm, ovate, rounded at base, acute at apex, mucronulate, thinly puberulous without; wings 3.5 × 1 mm, oblong-ovate, shortly clawed at base, obtuse at apex, thinly pubescent along

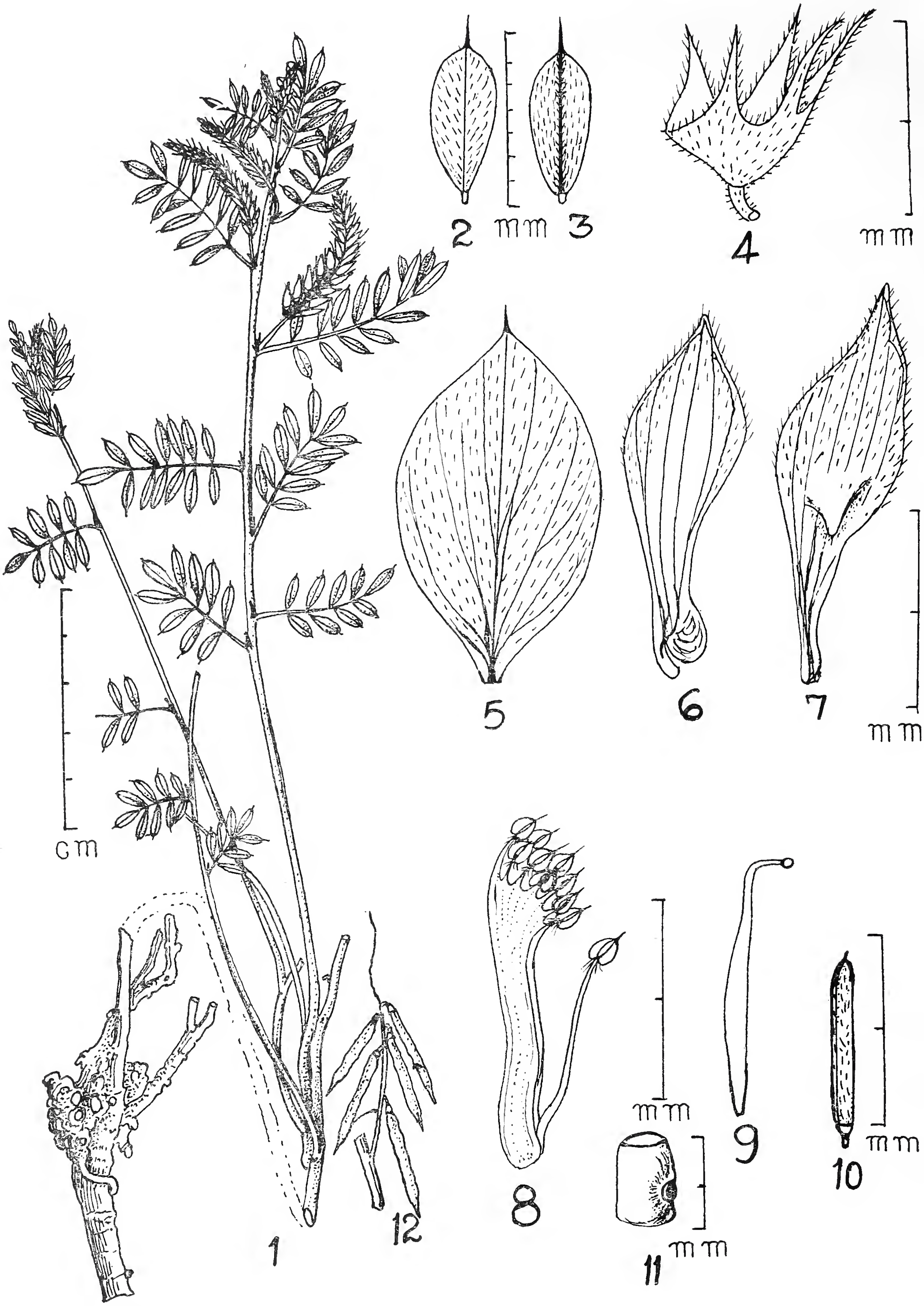

Fig. 1. *Indigofera sesquipedalis* C. B. Clarke ex Sanjappa, sp. nov. 1. A twig of the plant with root stock. 2. Leaflet — adaxial surface. 3. Leaflet — abaxial surface. 4. Calyx. 5. Standard. 6. Wing. 7. Keel. 8. Stamens. 9. Carpel. 10. Mature pod. 11. Seed. 12. Young pods.

the margins; keels 4 × 1 mm, spathulate, cuneate at base, acute at apex, spurred, thinly adpressed hairy; stamens diadelphous (9 + 1), 3-3.5 mm long, anthers sparsely bearded at base; ovary 1.5-2 mm long, oblong, 5-8-ovuled, glabrous; style 1-1.5 mm long, glabrous; stigma capitate. Pods 15-20 × 2-2.5 mm linear, cylindrical, reflexed, sutures thin, valves rounded, shortly apiculate, sometimes faintly torulose, thinly short adpressed pubescent, 5-8-seeded, septate between seeds, endocarp red-spotted; peduncles elongating in fruits. Seeds 2-2.5 × 1.5 mm, cylindrical, truncate at both ends, smooth, reddish brown.

Flowering: May — August.

Fruiting: August.

Distribution : INDIA: Khasia Hills—Meghalaya, Naga Hills — Nagaland and Aka Hills—Arunachal Pradesh (— Based on Biswas, Ind. For. Rec. 3(1): 17.1941).

Specimens examined: *At Cal*: *INDIA*: Meghalaya, Khasia Hills, Shillong, 5000′, 1 June 1885, *C. B. Clarke* 38232 (holotype); Maphlong, 5500′, 18 Oct. 1872, *C. B. Clarke* 18598 B, 18614 (paratypes); Normai, 4500′, 25 Aug. 1885, *C. B. Clarke* 40103 (paratype); Boga Pani, 2000′, 1 Jun. 1868, *C. B. Clarke* 7296; Shillong, 5000′, Oct. 1867, *C. B. Clarke* 5757; Loitlynghat, 5-6000′, 6 Dec. 1946, *F. Kingdon-Ward* 2; Khasia, *G. Mann s. n.* (Acc. no. 11007); Shillong, 5000′, May 1890, *Badal Khan s. n.;* Khasia, 6000′, *Hooker f. & Thomson s. n.*; Woodlands, New Colony, Shillong, 4 Jun. 1960, *R. K. Raivaid* 18184; 3-4000′, May, *Herb. Sulp. Kurz* 213, 521; 5000′, May 1878, *Forest Herb. no.* 756; 5000′, June 1876, *Herb, Sulp. Kurz* 262; Cherrah valley, 6000′, 1878, *Gallataly* 217 *pro parte* (Specimen on right hand side only); Shillong, 5000′, *E. B. Carter* 851; Dumpep to Shillong, 5-6000′, 4 Jun. 1911, *Burkill & Banerjee* 35206; Shillong to Dumpep, 4900′-6300′, 29 May 1891, *Burkill & Banerjee* 44, 24 May 1911, *Burkill & Banerjee* 45; on the way to Cherrapunji from Shillong between 14th and 15th mile, 2 Jun. 1958, *R. S. Rao* 2671; Shillong, 5500′, 21 Aug. 1886, *C. B. Clarke* 44617A (K, Photo BSI Neg. No. 5328B — CAL); Woodlands, Shillong, 23 May 1972, *H. Deka* 38472; Woodlands, Shillong, Sept. 1960, *Collector*? 21734,

At ASSAM: Umber falls, 18 May 1930, *P. C. Kanjilal* 8062; Peak forests, 6000′, 12 Jul. 1931, *Shriram Sharma* 9253; Khasia Hills, 5000′, Jun. 1876, *G. Mann* 262, 5000′, May 1878, *G. Mann* 756, 4-5000′, July 1879, *G. Mann s. n.;* Assam, locality? *G. Mann s. n. G. Mann* 262, *G. Mann s. n.* (Acc. nos. 7193, 7194, 7200), Station Nursery, Shillong, June 1949, *G. K. Deka* 22787; Elephant fall, 22 Jul. 1951, *H. Deka* 23273; Mulki, Shillong, 5800′, 10 Nov. 1930, *Shivaram Sharma* 8576; Upper Shillong, 30 Jul. 1942, *G. K. Deka* 21444; Woodland compound, Shillong, 30 May 1973, *S. Das* 13168; Mirang to Nongkhland, 15 Jun. 1958, *G. Panigrahi* 16159; Shillong to Cherrapunji, 14th and 15th mile, *G. K. Deka* 2671; Nongkrem, 3 Jun. 1914, *P. C. Kanjilal* 592 M; *Laitkar*, Shillong, 20 May 1963, *S. K. Kar* 32486.

At NEHU (*Shillong*) : Upper Shillong, 10 Sept. 1978, *B. Biswas* 48; 26 Sept. 1978, *Albert Solo* 146; 7 Sept. 1975, *A. Handigae* 10; Laitkon, 23 Jul. 1977, *K. M. Kuruvika* 42; S. E. falls, Shillong, 23 Aug. *Z. Pachuan* 28.

At DD: Khasia Hills, 5-6000′, *G. Mann* 213; Shillong peak, 5000′, 10 Aug. 1943, *N. L. Bor* 17996, 17997.

At LWG : Shillong peak, 17 May 1960, *R. V. Sitholey and party s. n.* (ACC. no. 43794); Cherrapunji, 5000′, 29 April 1962, *S. Chopra and party s. n.* (ACC. no. 48686).

NAGALAND: Naga Hills, May 1936, *N. L. Bor* 20836 (ASSAM); Naga Hills, 1935,

N. L. Bor 5330 (DD, K).

This species differs from *Indigofera heterantha* Wall. ex Brandis in the following characters :

In the protologue of *I. bracteata,* Baker (op. cit.) mentions 'leaflets 7-17', but all the specimens cited by him have only 5-7 leaflets and never more than 7. This is also true with

I. sesquipedalis C. B. Clarke ex Sanjappa, sp. nov.	*I. heterantha* Wall. ex Brandis
1. Shrub less than 1 m high.	1. Shrub or tree more than 1 m high.
2. Branches from the base, glabrescent.	2. Branches above the base, adpressed white pubescent.
3. Leaves petiolate.	3. Leaves sessile or sub-sessile.
4. Leaflets (5-) 7-11 (-17), thin, glabrescent above adpressed pubescent below.	4. Leaflets (5-) 7-15 (-25), coriaceous, densely adpressed pubescent on both surfaces.
5. Racemes peduncled.	5. Racemes sessile.
6. Anthers sparcely bearded at base.	6. Anthers glabrous at base.
7. Pods 1.5-2 cm long, deflexed-spreading, adpressed short pubescent.	7. Pods more than 2 cm long, spreading, adpressed long pubescent.

(ii) *Indigofera bracteata* Grah. (in Wall. Cat. no. 5477. 1831. *nom. nud.*) was validly described by Baker (1876) based on collections from Nepal (by Wallich), Khasia (by Hooker f. and Thomson) and Kashmir (by Thomson). On critical examination of the above specimens, it has been found that this species is a mixture of two taxa with distinct geographical distribution : Taxon 1 is restricted to Nepal and taxon 2 to Khasia Hills in Meghalaya (India). The differences between taxa 1 and 2 are described in the following table :

the specimens collected so far from Nepal as well as India. Even in the wrongly identified specimen [cited by Baker (op. cit.) as an exstipellate form from Kashmir — *Thomson s. n.*], the levels have only 13 leaflets. It is therefore, difficult to explain as to how such an error had crept into the descripion.

Baker (op. cit.) also states that he had not seen the mature pods and seeds of the species. Therefore, a detailed description of pods and seeds of the typical variety of the species is as follows :

Taxon 1	Taxon 2
1. Leaflets adpressed, pubescent on both surfaces.	1. Leaflets adaxially glabrous.
2. Pods less than 3 cm long with acute apex.	2. Pods more than 3 cm long with spine-pointed apex.
3. Sutures wingless or obscurely winged.	3. Sutures prominently winged.
4. Valves smooth.	4. Valves rugulose.

The specimens with characters of taxon 1 represent the typical variety i.e. *I. bracteata* Grah. ex Baker var. *bracteata* and those with characters of taxon 2 is described here as a new variety.

. . **Indigofera bracteata** Grah. ex Baker in Hook. f. Fl. Brit. Ind. 2 :100. 1876. var. **bracteata.**

Pods 2-2.8 × 0.2-0.25 cm, linear, straight, acute, glabrous, spreading, sutures narrow,

wingless to obscurely winged, valves smooth, sometimes faintly torulose, up to 9-seeded. Seeds 2 × 1 mm, cylindrical, truncate at both ends, smooth, deep brown (described from the specimen : Nepal, Kukni, Naikot and the valley of Likhu, 8 Dec. 1907, *I. H. Burkill* 29880 — CAL).

Distribution: NEPAL: Kukni, Patibay-yang, Sivapuri, Ranikarka (Bagdwar) — Endemic.

Indigofera bracteata Grah. ex Baker var. **khasiana** Sanjappa, var. nov. Syn. *I. bracteata* Grah. ex Baker in Hook. f. Fl. Brit. Ind. 2 : 100. 1876. *p.p.*

I. bracteata var. *bracteata* affinis sed differt foliis adaxiliter glabris, leguminibus plus quam 3 cm longis, suturis latis alatis, valvis rugulosis, opicibusque aristatis.

Holotypus lectus a *Hooker f.* & *Thomson s. n.* ad locum Khasia Colles, 5000 — 6000 ped., et positus in herbario CAL. Isotypi positi in herbario CAL, MH.

Indigofera bracteata Grah. ex Baker var. **khasiana** Sanjappa, var. nov. (Fig. 2).

Syn. *I. bracteata* Grah. ex. Baker in Hook. f. Fl. Brit. Ind. 2:100. 1876 *p. p.*

Allied to *I. bracteata* var. *bracteata* but differs from it in having adaxially glabrous leaflets, legumes more than 3 cm long with broad winged sutures, rugulose valves and spine-pointed apices.

Type: Khasia Hills, 5-6000′, *Hooker f.* & *Thomson s. n.* (holotype, CAL; isotype, CAL, MH).

Undershrub, branches slender, trailing, terete, (appear angular when dry), glabrous. Leaves 5-8 cm long, pinnate, alternate, petioles 1-2 cm long, canaliculate above, glabrous; leaflets (3-) 5-7, lateral opposite, 1.2-2.8 × 0.6-1.0 cm oblanceolate, elliptic-oblong, rarely obovate, cuneate at base, obtuse to rounded or slightly emarginate at apex, mucronate, pale green and glabrous above, glacous and thinly adpressed pubescent below; stipules 3-5 × 1-1.2 mm free-lateral, membranous, lanceolate, acuminate, striate, glabrous, stipels 2-2.5 mm long, prominent, free-lateral, setaceous, glabrous. Racemes 8-13 cm long, axillary, peduncles 3-5 cm long, striate, glabrous, rachis adpressed pubescent becoming glabrous. Flowers 10 mm long, violet-purple, white when dry: bracts 4-4.5 × 2-2.5 mm, lanceolate, cuspidate, veined, ciliate along the margins, longer than buds, caducous; calyx 1-1.5 mm long, companulate, 5-lobed, teeth short 0.5 mm long, deltoid, thinly adpressed pubescent without, ciliate along the margins; standard 10 × 4-5 mm, elliptic, rounded at base, acute, mucronulate at apex, densely short adpressed pubescent without tube 0.5-1 mm long; 10 × 2-3 mm, shortly clawed at base glabrous; keels 10 × 4 mm, spathulate, spurred, thinly adpressed pubescent without; stamens diadelphous (9 + 1), anthers apiculate; ovary ca. 7 mm long, linear, 8-10-ovuled, glabrous; style ca. 3 mm long, slightly bent, glabrous; stigma capitate. Pods 3-3.5 × 0.2-0.25 cm linear with spine-pointed apex, sutures broad, winged, valves rugulose, glabrous, reflected-spreading on rachis, 8-10-seeded, septate between seeds. Seeds (reddish-brown) 2 × 1.5 mm, cylindrical, truncate at both ends, smooth, brown.

Flowering : July—December.

Fruiting : November — December.

Distribution : *INDIA* : Endemic to Khasia Hills in Meghalaya.

Etymology : This variety is named after the type locality Khasia Hills in Meghalaya State.

Specimens examined : *INDIA* : Meghalaya, Khasia Hills, 5-6000', *Hooker f.* & *Thomson s. n.* (CAL, MH); Rambari, 4000' 10 Nov. 1871, *C. B. Clarke* 1531OD (CAL); Laitlyngrat, 6000', 17 Dec. 1946, *F. Kingdon-ward*

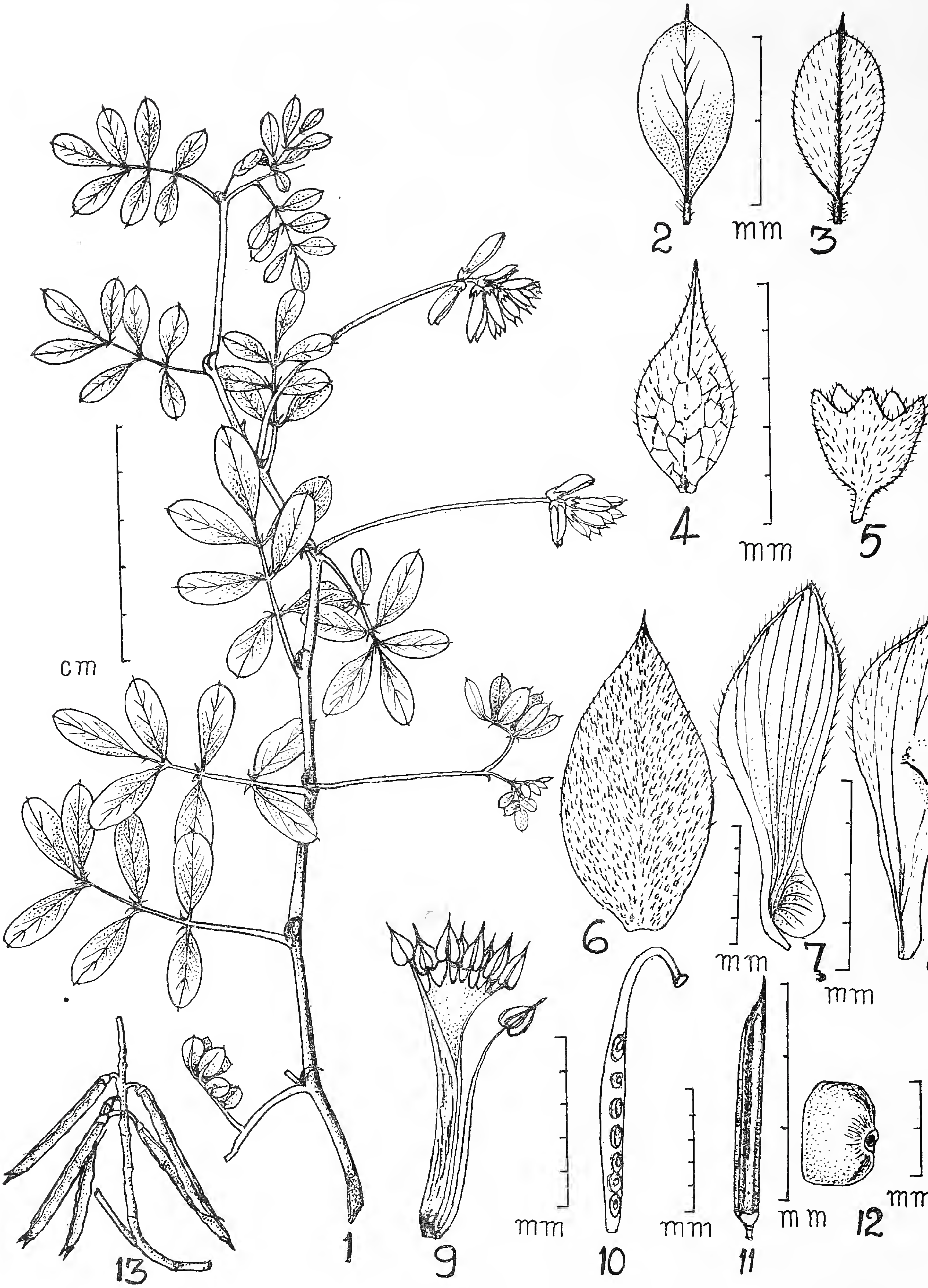

Fig. 2. *Indigofera bracteata* Grah. ex Baker var. *khasiana* Sanjappa. var. nov.
1. A twig of the plant. 2. Leaflet-adaxial surface. 3. Leaflet-abaxial surface. 4. Bract. 5. Calyx. 6. Standard. 7. Wing. 8. Keel. 9. Stamens. 10. Carpel. 11. Pod. 12. Seed. 13. Dehiscing pods.

s. n. (CAL); Maflong, 4 Oct. 1931 *Shriram Sharma* 9891 (ASSAM); Laitlyngrat, 17 Jul. 1946, *G. K. Deka* 21901 (ASSAM); Peak forest, 8 Sept. 1930, *P. C. Kanjilal* 8408 (ASSAM); Laitlyngrat, 17 miles from Shillong, 27 Aug. 1956, *G. Panigrahi* 3142 (ASSAM); Elephant fall, Shillong, 9 Oct. 1965, *H. Deka* 35591 (ASSAM); Shillong peak, 13 Oct. 1950, *G. K. Deka* 23052 (ASSAM); Laitlyngrat, 11 Aug. 1938, *R. N. De* 16909 (ASSAM).

ACKNOWLEDGEMENTS

I am thankful to Director, Botanical Survey of India, Howrah, for providing facilities, to Dr. K. Thothathri, Deputy Director, Central National Herbarium, Howrah, for encouragement, and to Dr. N. C. Majumdar for rendering diagnosis of 2 new taxa into Latin.

REVIEWS

1. GRASSES OF MARATHWADA. By B. W. Patunkar. pp. 300 (14 × 22 cm.) with 86 line drawings, 4 maps and one graph in the text. Jodhpur, 1980. Scientific Publishers. Price Rs. 100, US $ 20.

The work comprises the doctoral dissertation of the author and is divided into two main parts — the Introduction and the systematic treatment.

Marathwada is one of the four divisions of Maharashtra State and consists of five districts. It is situated on the Deccan Plateau at an average height of about 650 m. above sea level. Three vegetational types are represented in the area *viz.*, Tropical dry deciduous forest; Dry deciduous scrub jungle; and, Dry grasslands. Among the grasses, the sub-family Panicoideae is better represented than sub-family Pooideae and the tribes Andropogoneae and Paniceae are the dominant tribes in the region.

The Introduction gives general information on the topography of the region, its geology and soil types, its climatic features and the history of botanical exploration in the area.

The main part of the book deals with the systematic treatment of the Gramineae covering the general feature, distribution and relationships of the family. Gramineae has been divided into two subfamilies, each subfamily into several tribes each tribe into its constituent genera, and each genus into species keys are provided for each stage of classification. These keys have been suitably modified and adapted from Bor to include the taxa occurring in the district.

The tribes, genera, species and infraspecific taxa are alphabetically arranged. Each species has been numbered and followed by the nomenclature. Only pertinent literature has been cited in the synonymy. A detailed description is provided for the species finally there are remarks on the phenology, flowering and fruiting times, local names and uses wherever known, and the herbarium specimens studied. These specimens have been deposited in the Herbarium of the Department of Botany, Marathwada University. Diagrams have been provided for at least one species of each genus.

Altogether the work includes about 200 species belonging to 80 genera. Of these, five are new species. There is no doubt that the neglected and difficult family Gramineae has been carefully studied by the author and this compact book will be of much use to botanists, foresters, ecologists and agriculturists.

The main drawbacks of the work are its high cost and a large number of spelling and typographic errors over and beyond those listed in the errata. The keys to the tribes and genera are sometimes ambiguous and contradictory. The diagrams have suffered in the printing and are not clear.

A. R. DARUWALLA

2. A SYNOPTIC FLORA OF MYSORE DISTRICT. By R. R. Rao and B. A. Razi. pp. xii + 674 (22×14.5 cm) with a map. New Delhi, 1981. Today and Tomorrow's Printers and Publishers. Price Rs. 325/-, US $ 65.00.

Mysore District lies in the south of Karnataka State of peninsular India. This district is bordered by Kerala to the S. W. by Tamil Nadu to the South, and abuts on the Western Ghats. The northern and central portions of the district form a plateau whereas the southern, eastern and western regions are hilly. As a result of this varying topography, Mysore district has a variety of vegetation types from evergreen forests to scrub jungles as one travels from west to east.

The Mysore district covers an area of approximately 11,947 sq. kms. The present flora is based on the exploration of the area for over five years on the personal collections of the authors and on collections of previous workers. In the introduction to the flora, the authors have discussed the geography, geology, soil types and climatic factors of the region. Notes are added on the general vegetation and on recent introductions and new records for Mysore district. Cultural Plant Communities, including agricultural crops and ornamental plants are also listed.

All plants collected have been divided into four groups according to their habits, *viz.*, trees, shrubs, climbers & herbs. Each group is provided with an artificial key leading directly to the species. In case the habit of the plant is variable, it is included under more than one group. Both vegetative and reproductive characters are used in the keys. This presupposes an astronomical and intimate knowledge of all 1601 species described in the flora. The keys to the four groups occupy the major part of the book.

In the systematic treatment, the 170 families represented in Mysore district are arranged according to Geonquist (1968). However, the circumscription of the families is according to Hutchinson (1959) and the Seattle Code (1972). The genera and species included in each family are listed alphabetically. The species are serially numbered and the number corresponds to the one given to the same plant in the key to facilitate cross-reference. For the nomenclature of each species, only the original citation is mentioned and the synonyms have been omitted in most cases. A very brief description is provided with notes on the habitat, abundance, and flowering season of the plant. The vernacular local name is cited whenever known. Voucher specimens collected by the authors are listed and these specimens have been deposited in the herbarium of the Department of Botany, University of Mysore, at the Manasgangotri campus.

The work concludes with a selected bibliography, a list of drugs from plants found in Mysore district, an index to vernacular names and an index to botanical names.

Inspite of the unorthodox and laborious approach followed by the authors in the presentation of direct keys to the species, it cannot be denied that the work is a significant contribution to the regional floras of India. However, the price of the book (U.S. $ 65.00 — Rs. 325.00) is considerable and its production by Messrs Today & Tomorrow Printers and publishers is shabby. There is a large number of spelling errors, several pages are missing from the book and quite a few pages are not arranged in order (pp. 33-48 lie between p. 16 & p. 17; pp. 49-64 are missing; pp. 397-400 lie between p. 388 & p. 389).

A. R. DARUWALLA

3. ILLUSTRATIONS ON THE FLORA OF THE TAMILNADU CARNATIC. (Vol. 2 of the Flora of the Tamilnadu Carnatic series). By K. M. Matthew, pp. 46 + 1027 (25 × 17 cm). Tiruchirapalli, 1982. The Rapinat Herbarium, St. Joseph's College. Price Rs. 150.00 or £ 25.00 or $ 50.

AND

THE FLORA OF THE TAMILNADU CARNATIC (Vol. 3 of the Flora of the Tamilnadu Carnatic series). By K. M. Matthew — In two parts. Part I: Ranunculaceae — Labiatae (Lamiaceae). pp. 84 + 1284 (25 × 17 cm) with 93 plates & 1 map. & Part II: Plantaginaceae — Cycadaceae. pp. 84 + 1285-2156 (25 × 17 cm) with 20 plates & 1 map. Tiruchirapalli, 1983. The Rapinat Herbarium, St. Joseph's College. Price Rs. 250.00 or £ 40.00 or $ 80.

Vol. 2: Illustrations

The volume is an excellent example of dedicated team work. It comprises of 960 plates of line-drawings and 19 plates of 76 black and white photographs. All line drawings are based on meticulous observations and have a high standard of accuracy. The whole work has been carried out in the same pattern as of Drakestein van Rheede's plates of Hortus Malabaricus. Actual figures have been drawn by (a team of draftsmen, as author puts it) A. Rajasekharan (899), V. Guna (863), J. Jayarani (588), K. Navarasi (434), A. Arockiamary (246), J. Helen (196) and A. N. Nirmala (40), under the supervision of a technical adviser P. Michael and under guidance of research scholars S. J. Britton and N. Rani. All these people deserve compliments for valuable service to Indian Botany.

The author, while explaining the scope of the book, gives three reason for undertaking the work. Of the three, the third is more appropriate in Indian context, *viz.* the older publications are scarce, and even when reprints become available, these are prohibitively expensive. The author, in his comments, appreciates the earlier works by W. Roxburgh, N. Wallich, J. D. Hooker, J. F. Royle, R. H. Boddome and R. Wight; but has totally forgotten the greatest pre-Linnean work of Drakestein van Rheede, who pioneered in this field of plant-lithography with 794 plates on which, father of modern taxonomy, Carl Linneaus and subsequent taxonomist have established hundreds of species of Indian plants.

882 species from 841 genera belonging to 170 families have been illustrated in the volume. According to the author, 'almost all the indigenous genera included in the work are represented by at least one species, generally the less commonly known and so far unillustrated.' This statement is not quite correct, because a number of indigenous genera in the flora which do not have a representative figure in any of the previous works have been neglected and number of exotics (introduced as well as weeds) have found place in the volume. The statement however points out the intentions of the author and bottle-neck could be well attributed to his adoption of initial generic concepts according to Gamble's Flora of Madras Presidency.

Analysis of plates give following figures:

Species illustrated in the volume...............882
Species (illustrated) already having existing figures (mentioned in text, vol. 3).................676
Additional figures located in few previous works referred by us (not mentioned in vol 3).........94
First-hand species illustrated.................±112

As stated in the earlier review (for Materials for Tamilnadu Carnatic) the sequence of volumes of this series is running in reverse direction. The author himself has stated how that he had to publish the 'materials' before the flora because most of the foreign herbaria required his 'material' rather than his 'Flora'. Besides, in a way, the author was advertising the sale of his specimens for foreign herbaria for recovery of financial investments. But unfortunately, while keeping in mind interests of foreign herbaria, he has not cared for his common reader of Flora of Carnatic, who has to jump from volume to volume of such heavy compilation to get complete information on any single species.

The volume is brought out in great haste and at least 17 plates have been renamed after the completion of printing.

Plate — 114

Plant figured is *Zanthoxylum ovalifolium* Wight (not *Z. rhetsa* DC.). *Z. rhetsa* (Roxb.) DC. is a medium-size tree. Plant figured is a scandent shrub (see also vol. 3, page 215). The name *Z. limonella* (Dennst.) Alston accepted for this taxon is, according to F. A. Stafleu, an illegitimate name because it is based on invalidly published *Tipalia limonella* Dennst, the generic name of which is not validly published.

As pointed out in the analysis of plates, at least 112 species are illustrated in this volume which do not have any representative figure. The volume is recommended both for students as well as for the research fraternity.

Volume 3: *Flora — Part I & II*

This volume in two parts gives accounts of 2037 species from 990 genera belonging to 180 families as compared to 2376 species listed in the 'Materials' (Vol. 1); out of which 110 species of pteridophytes have not been dealt with.

Introduction (comprising of 24 pages) gives unnecessary details of every routine action taken.

Acknowledgements (again comprising of 5 pages) are mostly to foreign taxonomists and specialists, in addition to the Director and the Joint Director of Botanical Survey of India. Rather, the author seems unhappy with the BSI and has criticised the organisation for not helping him and finally suggesting a change in the attitude of the leadership of BSI.

Notable among the achievements of the books are two new names added to the Indian Plant Taxonomy, namely *Kleinia grandiflora* (DC.) Rani, a new combination resulting from *Notonia grandiflora* Wall. ex DC. and a new species — *Utricularia praeterita* P. Taylor.

A number of nomenclatural changes are adopted for Indian plants in place of old names; but no much attention has been paid to the works done by Indian botanists, taking only in account the opinions and personal help of overseas experts. Following nomenclatural changes are brought out in the text (p. 456).

Introduction includes justifications of the flora and explanations on I. Phytographic findings such as: A. Restricted distribution: — (a) Monotypic taxa and endemism, (b) Replacement taxa, (c) Endangered plants, (d) Suspected extinction, (e) Rare species, (f) Isolated populations, (g) Wild relatives of cultivated species. B. Extended distribution: (a)

Page no.	New name	Old name
358	*Crotalaria pallida* Ait.	*C. stricta* DC.
351	*Codariocalyx motorius* (Houtt.) Ohashi	*Desmodium gyrans* (Linn. f.) DC.
346	*Calpurnea aurita* (Ait.) Benth. ssp. *indica* Brumm.	*C. aurea* auct; Baker in FBI.
361	*Crotalaria angulata* Mill.	*C. biflora* (Linn.) Linn.
380	*C. pulchra* Andrews	*C. pulcherrima* Roxb.
490	*Caesalpinia decapetala* (Roth.) Alston	*C. sepiaria* Roxb.
542	*Entada rheedii* Spreng.	*E. pursaetha* DC.
973	*Enicostemma axillare* (Lamk.) R. Raynal	*E. hyssopifolium* (Willd.)

New Records, (b) West coast elements, (c) Mangroves, (d) Hill summits and (e) Weeds. II. Taxonomy. III. Nomenclature. IV. Distribution and finally a chapter on outlook for the future.

In the text families are arranged according to classification of Bentham & Hooker (1862-1883). Within the family format followed is as follows:

a. The name of the family (without author),
b. Family description,
c. Key to the genera,
d. Generic name (with author and reference of publication),
e. Generic description,
f. Key to the species,
g. Species name (with author and reference of the publication),
h. Vernacular (Tamil) names.
i. Species description,
j. Field notes,
k. Specimens examined, and
l. Distribution.

In addition to these, references in the synonymy, citations to previous two volumes for references of herbarium materials and figures (wherever made) are given.

At the end of the volume following data is given in form of appendices:

I. Authors bibliography compiled at the herbarium, Royal Botanic Gardens, Kew (1980), with corrections and additions of the names and works of the authors included in Matthew 1981 (Materials — vol. I).

II. Alphabetical list of authors of books referred.

III. List of periodicals abbreviated after Botanico Periodicum Hertianum, Pittsburgh (1968).

IV. Families of the plants of the Tamilnadu Carnatic incorporated in to the system of A. L. Takhtajan.

V. Families of the plants of the Tamilnadu Carnatic incorporated into the system of A. Cronquist.

VI. Synopsis of the field-trips.

VII. Chronological documentation of the field-work under the Carnatic flora project.

VIII. Library holdings, and

IX. Cumulative index to scientific names and Tamil names in volumes I, II & III.

The format followed in the text is good. Although, the author expresses satisfaction as regards to the updating the names in the flora, the lack of nomenclatural judgements is visible to a considerable extent. Misapplication of names is certainly as bad as the wrong descriptions.

The incomplete nomenclature especially the missing basionyms of the synonyms mentioned do not give the clear picture of the priority of publications. e.g.

p. 108 *Abutilon muticum* (DC.) Sweet
p. 124 *Pavonia glethomifolia* (A. Rich.) Garke
p. 271 *Zizyphus jujuba* (Linn.) Gaertner

p. 393 *Desmodium diffusum* (Willd.) DC.
p. 411 *Gliricidia maculata* (Steud.) Kunth.
p. 470 *Tephrosia procumbens* (Buch.-Ham.) Drumm.
p. 608 *Lagerstroemia speciosa* (Linn.) Pers.
p. 1361 *Litsea sebifera* (Willd.) Pers.

Certain names in the synonymy cited show priority over the accepted names. Nomenclature is not clear to the understanding of the reader. e.g.

Page	Accepted name or basionym	Synonyms cited
33	*Cardamine trichocarpa* Hochst. ex Rich. (1845)	*C. borbonica* Pers. (1809)
83	*Portulaca tuberosa* Roxb. (1824).	*P. pilosa* Linn. (1753).
242	*Zanthoxylon connaroides* Wight & Arn. (1834)	*Heynea trijuga* Roxb. (1815). *H. affinis* A. Juss. (1830).
281	*Cissus pallida* Planch. (1887)	*Vitis lanata* Roxb. (1834).
364	*Crotalaria spectabilis* Roth. (1821)	*C. sericea* Roxb. (1788).
543	*Leucaena leucocephala* (Lamk.) de Wit. based on basionym dated 1783.	*Mimosa latisiliqua* Linn. (1753).
553	*Polydontia ceylanica* Wight (1840)	*Pygeum zeylanica* Gaertner (1788).
621	*Jussaea adscendens* Linn. (1767)	*J. repens* Linn. (1753).
623	*Oenothera octovalvis* Jacq. (1760)	*Jussaea suffruticosa* Linn. (1753).
676	*Buplerum wightii* P. K. Mukerj. (1969)	*B. ramosissimum* Wt. & Arn. (1834).
810	*Senecio hohenackeri* Hook. f. (1881)	*Doronicum candolleanum* Wight & Arn. (1836).
1037	*Evolvulus emarginatus* Burm. f. (1768)	*Convolvulus gangeticus* Linn. (1756).
1129	*Spathodea falcata* DC. (1845)	*Bignonia spathacea* Roxb. (1800).
1203	*Endopogon cuspidatum* Benth. (1851)	*Endopogon versicolor* Wight (1849).
1275	*Plectranthus coleoidea* Benth. (1848)	*C. wightii* Benth. (1832).

Citations in the flora are unsatisfactory. Only typical variety of *Terannnus labialis* (Linn. f.) Spreng present in the area is given as *Terannus labialis* (Linn. f.) Spreng. ssp. *labialis* var. *labialis.* In case of typical variety, mention of ssp. and var. is unnecessary when no other variety for comparison is existant. Very often references of the basionym of the type species are given in the synonymy of the allied infraspecific taxon confusing the whole nomenclature. e.g. on page 76, in ssp. of *Drymaria cordata* (Linn.) Roemer Schultes ssp. *diandra* (Blume) Duke, the synonym (*Holosteum cordatum* Linn. is cited after ssp. *diandra* (Blume) Duke.

In many instances notes provided after particular species do not restrict to the taxonomic treatment or the ecological observations but gives presumptions without reasons.

Following names adopted in the text of the flora require reconsideration and likely to bring nomenclatural changes:

Polygala jacobii Chandrab. (p. 68)
Moringa oleifera Lamk. (p. 314)
Alysicarpus rugosus (Willd.) DC. (p. 338)
Desmodium diffusum (Willd.) DC. (p. 393)
Parkia biglandulosa Wight & Arn. (p. 547)
Ceropegia vincaefolia Hook. (p. 936)
Lycopersicon esculentum Miller (p. 1053)
Phaulopsis imbricata Sw. (p. 1194)
Premna serratifolia Linn. (p. 1229)

Surprisingly, distribution of an unidentified species is given as: From India to Micronesia and Tropical Australia; widely distributed in Malesia (Kern. l.c.).

Note under *Prosopis spicigera* (p. 549) is not called for. It is one of the common trees in Rajasthan which is known locally as 'Khijda'.

Randia malabarica Linn. (p. 696), *Randia candolleana* Wight & Arn. (p. 701) and *Randia rugulosa* (Thw.) Hook. are misplaced in the text and are not included in the generic key.

Inspite of few short-comings, the flora offers quite a lot of first-hand information on plants of Southern India and one must agree with the author that, considering the cost and benefit ratio, reader is offered much more for the price of Rs. 150.00.

The flora, undoubtedly, would be a welcome addition to all college and research libraries.

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. THE SUNDARBANS TIGER

The Sundarbans is a diverse ecosystem. It is the largest tract of estuarine forests in the whole world covering about 10,000 square kilometres and presently one of the largest chunks of undisturbed forests. It possibly forms an ideal habitat for the tiger though an inhospitable one.

The vast expanse of swamps studded closely with a network of tiny islands and mudflats supports a low wooded forest of high density. The rivers around the tiny mudflats form fantastic labyrinths, where the hard and pointed pneumatophores give a trying time to the life forms of the Sundarbans.

Human casualty has been reported from all over the 15 blocks (65 compartments) covering 2585 sq.km of Sundarbans tiger project area. This observation records the presence of aggressive maneaters all over the project area indicating perhaps a high population of tigers.

The migration of tiger from block to block and across international boundary is a feature, as the animal has been sighted negotiating vast expanses of open water. This may be in search of elevated lands above inundation level and also in search of prey, especially human beings.

The average annual human casualty has been reported to be 36, but unofficial reports record about 100 (the forest being contiguous with Bangladesh forests). Dead bodies could only be recovered from the maneaters in about 28.5% of cases.

Human casualty figures fluctuate from the lowest recorded during the rains to the highest during April and May. During these two months the entire estuarine forests become very active owing to millions of trees throwing out new flush of leaves and flowers which attract swarms of *Apis dorsata* and honey combs can be seen all over the project area. This coincides with the activities of all types of life forms such as Molluscs and Crustacea. The tigers seize this opportunity to kill large number of honey collectors besides fishermen, shell collectors, timber coupe workers, etc. during this season.

The maneaters have an uncanny understanding of human nature as they kill men between 7 a.m. to 8 a.m. (morning), 3 p.m. to 5 p.m. (afternoon) when the workers are either enroute to their work site or are preparing to return to their camps in the evening (80% human casualty). Some of the most notorious and cunning maneaters swim to boats, clamber in, choose their victim and jump into water with the dead body and get back to the forests. This usually occurs after 11 p.m. when the boatmen are fast asleep.

Middle aged men (between 35 to 45) form about 80% of human casualty figures.

Pigs and deer which are primary food animals occur in abundance but the terrain, is a serious handicap for the tigers to catch such animals and are compelled by circumstances, therefore, to take monkeys, fish, birds, crabs and even honey.

The maximum casualty occurs just before full moon and new moon.

The Sundarbans forest need to be cohserved not only for the tiger but to act as a natural barrier against severe cyclonic storms during the monsoon months. However, acute might be the immediate public need, these estuarine

mangrove swamp have to be preserved to fight the mighty tidal waves of the Bay of Bengal and to protect the lives and properties of millions of poor villagers residing adjacent to the forests. Project tiger is therefore essentially a environment conservation project.

The local people of the Sundarbans have a firm conviction that death is an inevitable phenomenon and occurs as decreed by the Tiger-God and there is nothing one can do about it; they have reconciled themselves to a co-existence with maneaters; as a supernatural creature that cannot be exterminated. The tiger is accepted as a hard reality in the life style of the Sundarbans and people are only made to observe elaborate rituals of ground rules to ensure co-existence with the maneaters. People of all religions, irrespective of their social position, caste and creed, sit together and prey for survival against this "magical" animal. This is the philosophy of man's relationship with the Sundarbans tigers.

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PLANNING & STATISTICS,
OFFICE OF THE CHIEF CONSERVATOR OF FORESTS, WEST BENGAL,
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January 22, 1984.

2. INTERACTION BETWEEN GAUR AND TIGER IN BHADRA WILDLIFE SANCTUARY

On 24.xi.1983, along with several forest officers I was on the wildlife viewing machan located at 'Chandrana Hadlu', a grassy swamp in Muthodi range of Bhadra Wildlife Sanctuary (Karnataka State). We were observing (through 8 x 50 binoculars) an artificial salt lick in the open, surrounded by young Teak plantations.

At 6.15 p.m. a young Bull Gaur (*Bos gaurus*) came rushing out of the teak plantation and stood looking back anxiously emitting snorts of alarm. Within a couple of minutes a Junglefowl (*Gallus sonneratii*) gave alarm, followed by a herd of spotted deer (*Axis axis*) in the woods. Along the path used by the gaur, a tigress (*Leo tigris*) came out of the plantation into the open. The gaur which was about 30 metres away started off to run, then stopped. The tigress came out slowly, emitting low moans but showing no sign of aggression or hostility. The Gaur stood its ground, with ears pricked forward alertly. At one point the two animals were only about 20 metres apart, the tigress totally ignoring the gaur, which took a couple of hesitant steps towards the tigress and then stopped. The tigress strolled onwards leisurely, sniffing at the grass and moaning now and then. While the tigress drank from a pool of water 80 metres away, the gaur relaxed and started feeding. Throughout the entire period the tigress totally ignored the gaur as well as the continuous alarm calls of spotted deer and sambar (*Cervus unicolor*) from the surrounding woods. A wild tusker in *musth*

which was about 100 metres away from the pool also ignored the tigress. Alarm calls indicated the onward passage of the tigress as she went out of our sight.

Though tigers appear to prey on gaur fairly frequently in the Bhadra Wildlife Sanctuary as well as in Nagarahole National Park, it is difficult to say whether this particular medium-sized tigress could have taken on the young bull gaur. Further, two tigers had killed two domestic cattle and consumed a large amount of meat from one of the kills two days earlier at a spot barely two kilometres away from the *machan*. It is quite possible that the tigress which we saw could have been one of them, and so was not hunting. In any case the gaur seemed to be aware that it posed no immediate threat.

Similar interaction between the Indian Wild Dog (*Cuon alpinus*) and their prey like sambar has been reported by A.J.T. Johnsingh in the Bandipur Tiger Reserve.

K. ULLAS KARANTH

HON. WILDLIFE WARDEN,
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January 22, 1984.

3. A NOTE ON THE LONGEVITY OF TWO SPECIES OF WILD CARNIVORES IN CAPTIVITY

Not much information is available on the longevity of Indian wild animals in captivity. The present note deals with the longevity of two species of wild carnivores recorded at the Nandankanan Biological Park, Orissa.

Leopard Cat (*Felis bengalensis*). A male received as a kitten on 26.iv..1970 died on 21.iii.1983 after remaining for 12 years, 10 months and 24 days in captivity. The estimated age at the time of death was approximately 13 years. After death it weighed 3.015 kg and measured 93 cm tip to tip including 29 cm long tail. This was housed in an enclosure having a floor space of approximately seven square metres; height 2.80 metres and with suitable cavelike retiring dens. It was fed with 300 gm of goat meat and 50 gm of beef daily. One live chicken was given once a mouth in place of goat meat and beef.

A female Leopard Cat of New York Zoological Park lived for 13 years, 6 months and 4 days (Crandall, 1965). Flower (1931) gives the longevity of a specimen of this species as 12 or 13 years.

Himalayan Palm Civet (*Paguma larvata*). A female received as a young in the park on 1.x.1968 died on 7.iv.1983 after remaining for 14 years, 6 months and 7 days in captivity. The estimated age at the time of death was about 15 years. After death it weighed 5.4 kg and measured 110 cm, including 46 cm long tail. This was living in an enclosure similar to that of the Leopard Cat's. It was fed with 300 gm ripe banana, 50 gm minced goat meat, 200 ml milk and 50 gm boiled rice per day.

Flower (loc. cit.) has given the longevity of this species as 15 years, 5 months and 17 days. The best longevity of this species recorded at the New York Zoological Park was 11 years, 3 months and 27 days (Crandall, loc. cit.). The average span of life of captive civets in general is given as 12 to 15 years (Prater 1971).

However, we would be interested to know the longevity of these two species of Indian wild carnivores established in other Indian Zoos.

NANDANKANAN BIOLOGICAL PARK,
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L. N. ACHARJYO

WILDLIFE CONSERVATION OFFICER,
145-SAHEED NAGAR, BHUBANESWAR-7,
ORISSA,
January 22, 1984.

S. K. PATNAIK

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PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay, PP 88-94.

4. RECORD OF A PYGMY WHITE-TOOTHED SHREW, *SUNCUS ETRUSCUS* (SAVI, 1822) FROM DAMAN, NEPAL

(*With a text-figure*)

The Pygmy Whitetoothed Shrew, *Suncus etruscus* is widely distributed from the Mediterranean zone of Europe and North Africa, Asia Minor, Indian peninsula to South-East Asia (Ellerman & Morrison-Scott 1951). In Nepal this species is represented by the subspecies *S. e. pygmaeoides* Anderson, 1877 (Frick 1968, Mitchell & Punzo 1976). It is known from Kakani, Melumchi (Mitchell & Punzo 1976), Katmandu, Gurjakhani (Ingles *et al.* 1980), Dunche (Abe 1982).

On September 1980 the French entomologist T. Deuve caught in an insect trap a *Suncus etruscus* at Daman (Mahabharat Hills, alt. 2600 m). The shrew, a young male, had been caught in a grove of rhododendrons near a forest of pines.

TABLE 1

MANDIBULAR MEASUREMENTS: RESULTS

Variable	1	2	3	4	5	6	7	8
Daman	.86	.99	3.57	2.93	1.31	1.08	1.46	1.99
Cerezo, NW Spain	.62	.81	3.33	2.88	1.10	1.05	1.28	1.90
Gard, S. France	.65	.86	3.32	2.85	1.25	1.04	1.47	1.92
Gard, S. France	.75	.85	3.38	2.81	1.11	1.02	1.43	1.91
Gard, S. France	.73	.87	3.41	2.87	1.17	1.11	1.42	1.96

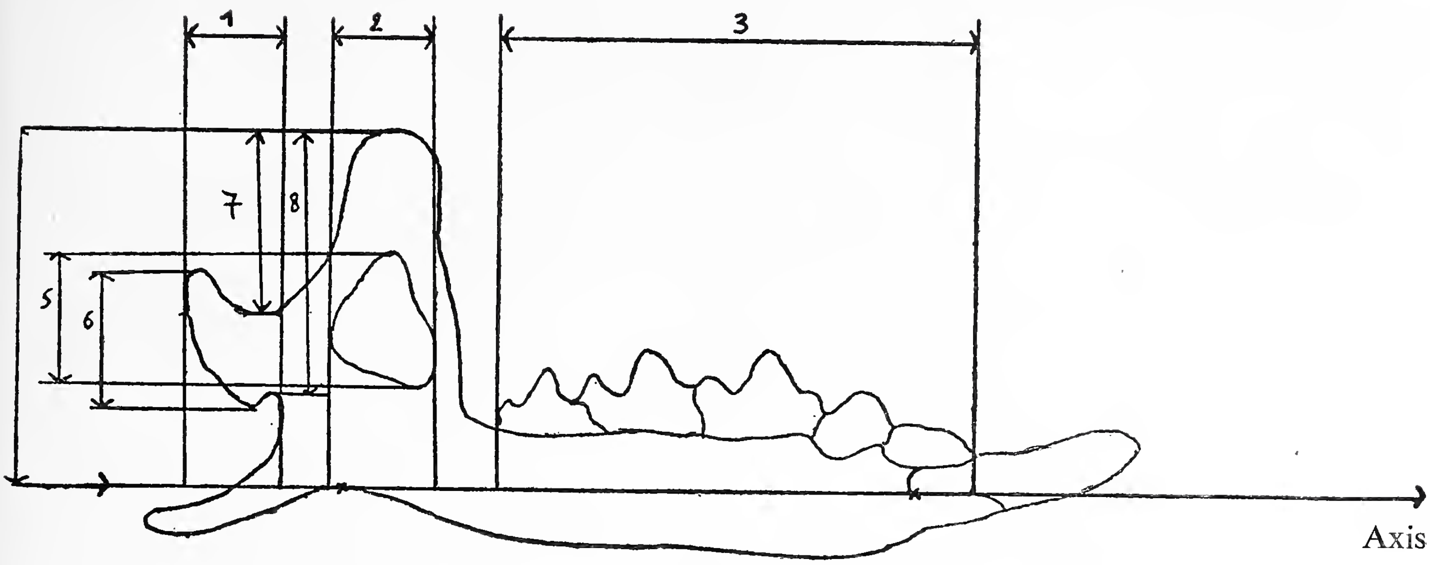

Fig. 1. Mandibular measurements.

Measurements: All measurements are in millimetres.

EXTERNAL. Length of head and body = 35.6
Length of tail = 34.2

CRANIAL. Total length = 12.68
Maximum breadth of rostrum = 3.91

MANDIBULAR. Mandibular measurements are indicated on Figure 1. Results on table 1.

According to Corbet (1978): "it seems doubtful if some or any, of the Indian forms allocated to this species (*S. etruscus*) by e. and M. S. are in fact conspecific." Therefore I think that it is interesting to present here, comparative, mandibular measurements of this species from West Europe with the hope that mandibles of other *S. etruscus* from the Indian peninsula will be measured for a comparative study.

ACKNOWLEDGEMENT

I am grateful to T. Deuve for the donation of the shrew.

PATRICK BRUNET-LECOMTE

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January 8, 1984.

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MITCHELL, R. & PUNZO, F. (1976): New mammal records from Nepal. *J. Bombay nat. Hist. Soc. 73*: 54-58.

5. FEEDING ACTIVITY IN THE CAPTIVITY OF THE WESTERN GHATS SQUIRREL *FUNAMBULUS TRISTRIATUS* WATERHOUSE[1]

(*With a text-figure*)

INTRODUCTION

The Western Ghats squirrel (*Funambulus tristriatus* Waterhouse) is an important rodent pest of cacao (*Theobroma cacao* L.) in south India (Bhat *et al.* 1981). But no effective method has been evolved so far for its control. Trapping by offering baits is one of the methods usually tried for controlling this squirrel. If this type of control of rodent pests is to succeed the schedule of baiting must coincide with the peaks of feeding of the target animal. In this report the observations made by us on the rhythm of feeding of the Western Ghats squirrel are discussed.

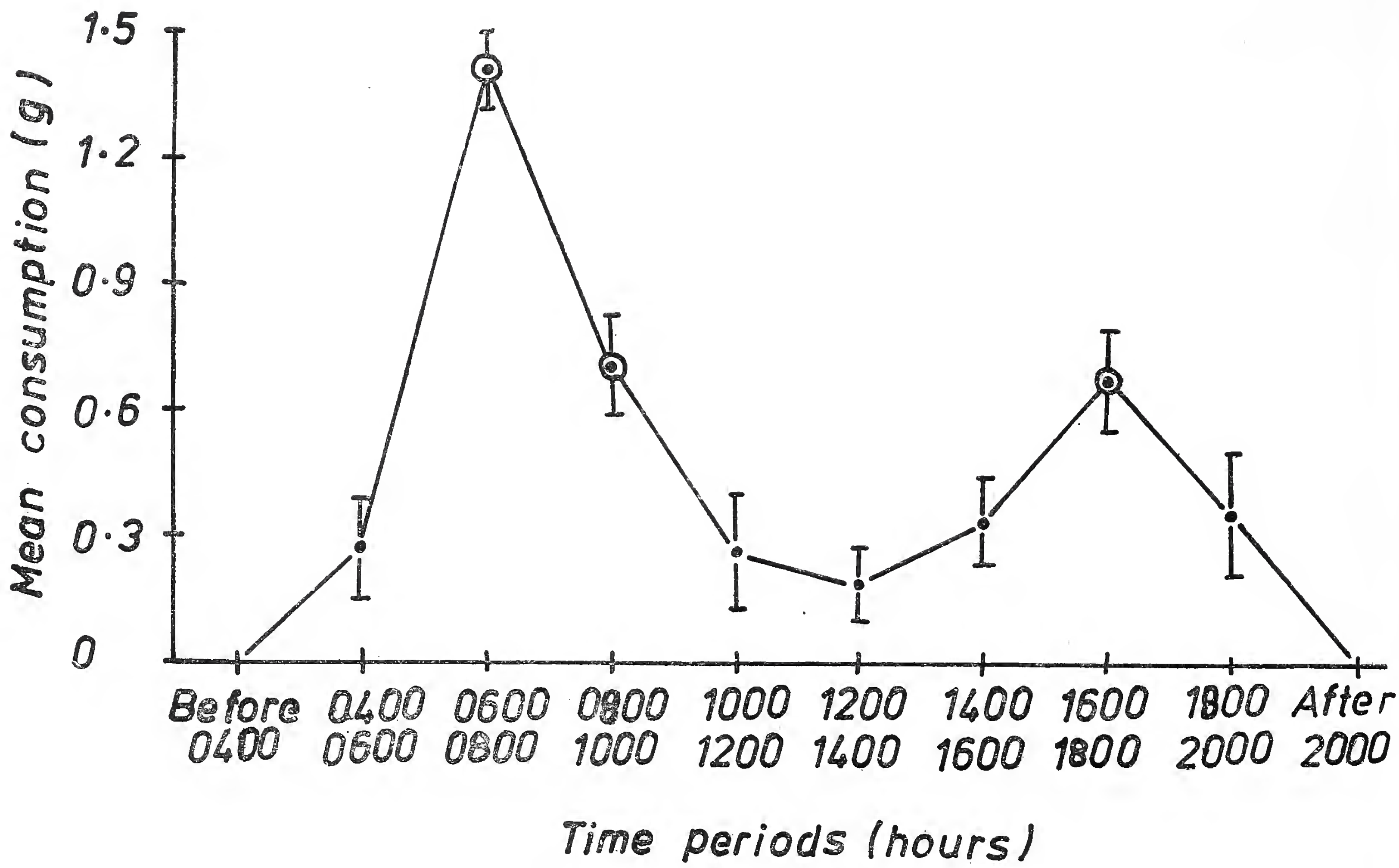

Fig. 1. Feeding pattern of *Funambulus tristriatus.*

MATERIAL AND METHODS

The study was undertaken in the laboratory of the Central Plantation Crops Research Institute, Regional Station, Vittal, Dakshina Kannada district of Karnataka under natural daylight in November 1978. Six adult Western Ghats squirrels (3 ♂♂ and 3 ♀♀) of recorded

[1] Part of the thesis submitted to the University of Calicut by the first author for the award of Ph.D. degree 1983.

body weights were lodged individually in cells of 50 × 30 × 30 cm. These squirrels were allowed to acclimatise themselves to the conditions in the cage for five days prior to the experiment. On the sixth day each squirrel was provided with weighed quantity of paddy grains, previously air dried to a constant weight. The experiment was continued for 10 days. Each day the consumption of paddy was recorded at two-hourly intervals between 0400 and 2000 h. The weighing was done to the nearest 0.5 g using a common counter balance. Absolute consumption values were transformed to g/100 g body weight of the animal. The average consumption during each period was computed and analysed statistically.

Results and Discussion

The data (see Fig. 1) revealed the presence of distinct bimodal feeding pattern in this squirrel. Feeding was first observed around 0600 h, increasing rapidly thereatfer. The overall mean consumption per animal per two-hour period was 0.54 ± 0.02 g. The morning peak in feeding (1.44 ± 0.09 g) was observed around 0800 h. After 0800 h the feeding activity lessened gradually reaching a minimum (0.18 ± 0.08 g) at about 1400 h. Feeding activity increased again gradually after 1400 h reaching a peak around 1800 h. Thereafter feeding slowed down and ceased at about 2000 h. Feeding was never observed at night. It is evident from this study that baits for these squirrels are best set up in the early hours of the day.

Acknowledgements

We are grateful to Dr N. M. Nayar, former Director, CPCRI, Kasaragod, for laboratory facilities at CPCRI (Regional Station) Vittal and Shri B. P. Nair CPCRI (Regional Station, Vittal) for statistical analysis. One of us (SKB) is thankful to the Council of Scientific and Industrial Research, New Delhi, for a fellowship.

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Kerala-673 635,
May 16, 1984.

S. KESHAVA BHAT[1]
D. N. MATHEW

Reference

Bhat, S. K., Nair, C. P. R. & Mathew, D. N. (1981): Mammalian pests of cocoa in south India. *Trop. Pest Mgmt.* 27:297-307.

[1] *Present Address*: Central Plantation Crops Research Institute, Reg. Stan., Kayangulam, Kerala-690 533.

6. REPORT ON THE OCCURRENCE OF THE FAWN-COLOURED MOUSE, *MUS CERVICOLOR CERVICOLOR* HODGSON, 1845 [RODENTIA: MURIDAE] IN THE ANDAMAN AND NICOBAR ISLANDS, INDIA

A small collection of rodents obtained by Shri P. K. Das, Zoologist, Zoological Survey of India, from the Andaman and Nicobar Islands included a grey-bellied mouse with

bicoloured tail which was identified as the Fawn-coloured Mouse, *Mus cervicolor cervicolor* Hodgson.

According to authoritative literature this species occurs within the Indian limits in southern India, Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, Meghalaya, Nagaland, Arunachal Pradesh but it has not yet been reported from the Andaman and Nicobar Islands and the present material constitutes the first authentic record of its occurrence in the Andaman and Nicobar Islands, India.

The details of the specimen are given below. The external measurements were taken in the field by the collector. All measurements are given in millimetres.

Material. 1 adult ♀; Z.S.I. Registration Number 21113; in alcohol; Wrightmyo, South Andaman Island, Andaman and Nicobar Islands; 10 April 1975; P. K. Das Collector; deposited in the National Zoological Collection of India, housed at the Zoological Survey of India, Calcutta.

Measurements. External: Head and body 89; tail 89.5; hindfoot 17; ear 13.

Cranial: Occipitonasal 22.3; condylobasal 21.0; nasal 8.4; palate 11.3; bulla 3.6; molar tooth row 3.4; anterior palatal foramen 5.1; diastema 6.0.

The tail is usually shorter than the head and body length in *Mus cervicolor*, but three out of the four examples of this sub-species from Nepal have the tail longer (Ellerman, 1961). In the above-mentioned example from the Andamans, the tail is more or less equal to the head and body length.

The specimen was trapped outside the kitchen of the Forest Rest House at Wrightmyo, South Andaman Island.

ACKNOWLEDGEMENTS

We thank the Director, Zoological Survey of India, Calcutta, for providing facilities, and Dr. B. Biswas, Emeritus Scientist, Z.S.I., Indian Museum, for going through the manuscript and for valuable suggestions. We thank to Dr V. C. Agrawal, Superintending Zoologist, and to Shri P. K. Das, Zoologist, for suggestions and encouragement.

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA-700 087,
January 22, 1984.

AJOY KUMAR MANDAL
M. K. GHOSH

7. A LARGE FLOCK OF MIGRATING WHITE STORKS

On 8.i.1981 at about 2.00 p.m. while returnning from Kalakad to Palayamkottai, I saw an unusually large assemblage of white storks (*Ciconia ciconia*) on either side of the road from Kalakad to Nanguneri east of hamlet Subramaniapuram.

There had been some recent showers. The ground and grass were wet. The area consisted of fallow fields. On the north of the road are the hillocks, where A. J. T. Johnsingh studied Indian Fox and a small rain fed irrigation tank. Sheep, goats, buffaloes and cattle were grazing to make it a perfect pastoral setting. The white storks are not uncommon or unknown in this area as it has been described in Tamil Sangam Literature said to be 3000 years in age.

Near scientific descriptions of its looks, migratory habits and habitat have been recorded by the Tamil Poet Sakthimuttar, The lines *"Pazhampadu Panayin kilangu Pilanthanna pavala kurvai sengal narai"* refer to the commissure of the beak which looks like the cleft

on the palmyrah seedling, coral coloured sharp beak and red legs. But what is uncommon is the large numbers seen. Salim Ali in his THE BOOK OF INDIAN BIRDS states that it is a winter visitor in small numbers. I counted them dividing the area into smaller sections based on the land marks and counting in the direction opposite to their general movement they turned out to be 360+. They were foraging and moving in a generally southerly direction.

Another striking characteristic was the spacing between adjacent individuals which was about 8-10 m. The spacing was consistent when two birds moved too close, one flew to the nearest opening available.

On enquiry from local cowherds I learnt that these birds arrived in small groups of 10 or 20, from about noon. They were unmindful of the grazing cattle. They were still foraging when I left at 4.30 p.m.

J. MANGALRAJ JOHNSON

WILDLIFE WARDEN,
MUDUMALAI WILDLIFE SANCTUARY,
TEMPLETON COTTAGE, VANNARPET,
UDHAGAMANDALAM-643 001,
TAMIL NADU,
March 3, 1982.

8. PUDDLE-FEEDING OF FLAMINGOS *PHOENICOPTERUS ROSEUS* IN INLAND TANKS

In Koonthakulam (77.46 E., 8.29 N., 60 m above MSL) situated in Nanguneri Taluk, Tirunelveli District, Pelicans, Painted Storks, Little egrets. Cattle egrets, Cormorants, Night herons and Pond herons breed. The tank contains water generally between the months September and April depending on rains, letting in of water from Manimuthar and letting out of water for irrigation. The breeding generally coincides with availability of water in tanks of Koonthankulam and nearby tanks.

Flamingos (*Phoenicopterus roseus*) are seen feeding in small groups of 5 to 27, when the water is shallow. When there is heavy rainfall and tanks get filled with fresh water flamingos leave to return after 15-21 days. Now that we have taken up planting of *Acacia arabica* in the foreshores of the tank, I frequently enter the tank bed, which is partly or mostly dry and noticed that they could be approached very close as near as 30 m. It is then that I noticed that they make a puddle with their feet continuously while feeding. The head is kept partly submerged in water or kept near the surface. They stand either very close to the edge of the water or in shallow areas where the depth of water is around 15 cm to 30 cm (as measured after the bird left). Keeping the head in the centre the legs are moved in quarter, semi- or three-quarter circles in clock wise and anticlockwise directions in slowly closing circles. While bringing the legs close to the head, the neck is bent but the head is kept in the same position continuously without lifting up the head. The puddling is effected by bending and lifting the legs and again thrusting into the tank bed ooze. While lifting legs the toes are partly closed. Flamingos found here are sometimes in breeding plumage. It has been reported earlier that Flamingos were faily common throughout the Tirunel-

veli District and large flocks numbering 300 were seen in July 1898 (Stuart Baker in GAME BIRDS OF INDIA, BURMA AND CEYLON. 1921, Vol. 1, page 4).

J. MANGALRAJ JOHNSON

WILDLIFE WARDEN,
MUDUMALAI SANCTUARY,
UDHAGAMANDALAM 1,
TAMIL NADU,
March 4, 1983.

9. OCCURRENCE OF LESSER FLAMINGO *PHOENICONAIAS MINOR* (GEOFFROY) IN POONA, MAHARASHTRA

Some eight kilometres west of Poona, lies the man-made lake of Pashan, along the stream named 'Ram Nadi'. Barring the summer hot weather season, the lake is fed by this stream. With the drying up of the shoreline, a large muddy expanse of the lake bed attracts a number of birds such as the Openbilled Storks, Painted Snipes, Yellow-wattled Lapwings in addition to the locally resident birds.

On the 29th of June 1982 a lone Lesser Flamingo (*Phoeniconaias minor*) was seen feeding along with two Openbilled Storks. This is the first time the former species has been seen in the area. The bird was uninjured and when disturbed would fly away to the other edge of the lake. It roosted at the lake, as was confirmed one night by a friend.

We last saw this bird on the 17th of July 1982 and photographed it. The *Checklist* by H. Abdulali (1981) lists the bird as stray, in flocks or parties. While the HANDBOOK, Vol. 1 (1969) gives the bird an 'uncertain status' with birds seen all round the year; specimens recorded as far south as Bombay and Secunderabad, the latter city being south of Poona. The article of W. B. Trevenen (1922) writing on the birds of Poona does not mention this bird.

TAEJ MUNDKUR

124/9 ERANDAVANA,
POONA-411 004,
January 21, 1983.

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10. SIGHTING OF RINGTAILED FISHING EAGLE AT VIHAR LAKE, GREATER BOMBAY

This is for the record of BNHS that on 7th August 1983 after the bird watching arranged by BNHS some of the members, including the undersigned had walked to Vihar lake. At Vihar Lake among a large gathering of about 25 Brahminy kites (*Haliastur indus*), both

immature and mature, a lone Ringtailed Fishing Eagle (*Haliaeetus leucoryphus*) was observed. The Fishing Eagle which has not been sighted in this part of Maharashtra could be a stray which had come with the group of Brahminy kites. The bird in question was unmistakably a Ringtailed Fishing Eagle due to the following, characteristics:

(i) Size — The size was very large, easily comparable with the Brahminy kites, as it chased the kites to snatch the fishes they had captured. The size of the eagle was atleast $1\frac{1}{2}$ times of the average Brahminy kites.

(ii) The ring round the tail was very clearly visible, when the eagle during its course of flight, was banking among the Brahminy kites.

(iii) When the eagle perched in a palm tree the head with pale golden brown colour was unmistakable. So also was the stance of perching with the wing extending upto the tail, more like that of vultures.

I have seen ringtailed fishing eagles at Bharatpur and also in Northern India. The identification was done at the site itself, as we had THE BOOK OF INDIAN BIRDS. However, before writing this note, other sources have been checked up regarding identification. We could not get a photograph, as the light was not good for getting a picture in flight. The other members who were with me were Messrs N. D. Mulla, S. D. Bhowmick. V. James and Feroze Mistry.

D. P. BANNERJEE

8/A DEVYANI APARTMENTS,
M. G. ROAD,
BORIVLI (E), BOMBAY-400 066,
September 26, 1983.

11. SOME OBSERVATIONS ON NATURAL CHEER PHEASANT, *CATREUS WALLICHII*, POPULATION AT MUKTESWAR RESERVE FOREST, KUMAON, NAINI TAL, U.P.

Cheer pheasant, *Catreus wallichii*, is the only representative of the genus *Catreus* of Phasianidae family. In recent years, concern has been expressed about the status of the species which has disappeared from many of its former haunts (Gaston 1979). An approximate estimate of the total world population of the bird is worked out to be around 5000 only (Gaston 1980) and the bird has been included in Appendix I of the Red data book of the IUCN.

Many authors have given the distribution of Cheer pheasant as North-West Himalayas from Hazara in West Pakistan, Kashmir, Himachal Pradesh, Garhwal and Kumaon, and up to West Central Nepal (Ali & Ripley 1969, Stuart Baker 1928, Delacour 1977). Even as early as 1922, Beebe had reported that fewer Cheer pheasants are met with than any other pheasant in the wild, excepting the Tragopans. One of the reasons given by Beebe was that even within their natural habitat they are very much confined to particular localities (Beebe 1922). Recent information shows that the bird is virtually extinct from Pakistan (Gaston 1980). Several areas in Himachal Pradesh hold populations each likely to be in excess of 50 birds and the Ravi valley population of more than 100 birds is considered to be the largest known population. But densities in all the

localities appear to be low, with the densest population in the Chail Wild Life Sanctuary (6 pairs/Km^2) and each population is isolated (Gaston 1980, Gaston & Singh, J. 1980). Lelliott & Yonzon (1980) conducted a short survey in western Nepal for locating Cheer pheasants which turned out to be futile. In a later survey, conducted in 1979 and 1980, Lelliott (1981) could locate Cheers in one area in west central Nepal above 'Muri' village in the Athhazar Parbat region.

There are very few authentic records of the presence of Cheer in the Kumaon hills in recent years. Nearly 20 years ago, Dr (Kr.) Suresh Singh of this Institute had seen a pair of Cheer crossing the road near Mahesh Khan which is in between Bhowali and Ramgarh in Naini Tal District (Singh, K. S. 1982, *pers. comm.*). Lamba (1977) mentions that the species was widespead in the Uttar Pradesh foothills 20 years ago but has since decreased drastically. Singh was of the view that a small population of Cheer pheasant could be present still at Mukteswar for which he invited Dr. A. J. Gaston of Canadian Wildlife service to survey the area. Gaston could not locate any Cheer at Mukteswar and was doubtful if Cheer was present in the area (Gaston 1979). I also surveyed the area twice earlier for getting an idea about the different species of pheasants present in the Mukteswar reserve forest, but could not get any evidence for the occurrence of Cheer pheasants, either by direct observation or from local enquiries. However, quite surprisingly, a remnant Cheer pheasant population has been observed during a recent survey conducted at Mukteswar.

The survey was conducted on 4 days from 21st (evening) to 24th (morning) November, 1980, to locate some pheasants at Mukteswar for the purpose of studying their behaviour. Mornings and evenings on these days were spent in the probable pheasant habitat of the reserve forest. On 21st evening while visiting the area north-west and below the temple I heard the feeble chuckling sound of Cheer pheasants, with which by now, I was quite familiar from captive birds. On 22nd morning at 6.05 a.m. I reached the same spot and watched for the birds. The atmosphere was very clear without any fog or rain. By 6.15 a.m. I could hear the chuckling sound and by 6.17 a.m. located an adult male Cheer pheasant, perched on a small oak tree about 6 metres above the ground.

This male Cheer was observed continuously for 11 minutes from 6.17 a.m. to 6.28 a.m. without the help of binoculars. The bird was sleeping, perched on a branch very near to the main stem. The tail was held at an angle towards the ground and the legs were covered by the body feathers. Some feeble chuckling sound was heard again a short distance away and a female Cheer was located. At 6.19 a.m. the male got up, defecated, and looked around. Suddenly it partly spread its wings and produced calls exactly like the cock bird at feeding time in captivity. The female reciprocated with the chuckling sound. At 6.20 a.m. the male Cheer presumably after seeing the observer, flew down producing a high metallic koel like alarm call. The same sort of alarm call was heard within seconds from an estimated 30 m further, clearly showing the presence of another pair. At 6.22 a.m. the pair was seen foraging on the ground, within 3 m of each other. Another Cheer chuckling was heard from a different direction showing the possibility of one more pair within the small area. At 6.28 a.m. the Cheer pair was lost from sight, but the chuckling sound was heard for some more time. First sunlight was observed at 6.55 a.m.

The observation gives some more evidence

to the view that Cheer pheasants roost on trees (Ali & Ripley 1969) as opposed to the view that they roost on ground (Delacour 1977).

Cheer habitat at Mukteswar

According to Ali & Ripley (1969) the Cheer pheasants inhabit steep, rugged hill-sides in oak forest covered with long grass and scrub cut up by wooded ravines. It was the lack of adequate long grass in the reserve forest which made Dr Gaston to doubt the occurrence of Cheer in that area. However, the slope on the north-western side of the temple does have a patch, approximately 2 sq. km in area which has long coarse grasses and thus is suitable as a Cheer habitat. This grass area appears to be rather isolated since similar areas were not seen in the surrounding forest. In this context it may be recalled that earlier observers had also noticed that Cheer inhabits very restricted areas and thus can be called stenecious.

The site where birds were observed is a slope of about 60°. More than 25% of the area is covered by rocks which are not easy for a man to climb without help. Sparsely scattered secondary oak and pine trees were present which were considered as suitable roosting trees for the birds. The area is very near to human habitation. The local people keep dogs which may be disturbing the birds. During my visit dogs were seen frequently and barks were heard quite often. To some extent, the birds seem to have adjusted to this as they did not react when a bark was heard at the site. The most unfortunate part about the habitat is that the area is not under the control of Indian Veterinary Research Institute, Mukteswar-Kumaon and people frequently cut the grass and graze domestic animals which will reduce the grass coverage drastically.

Acknowledgements

I am grateful to Dr (Kr) Suresh Singh, Administrator, World Pheasant Association, India for suggesting the study and for the critical assessment of the note during its preparation. I am also thankful to Director, I.V.R.I., and Head, Division of Epidemiology, I.V.R.I. for allowing me to carry out this study.

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12. POSSIBLE NORDMANN'S GREENSHANK IN NEPAL

On 28th January 1981, whilst walking along the Rapti Dun near Sauraha in southern Nepal, I noticed what appeared to be a group of common Greenshank (*Tringa nebularia*). On closer inspection I realised that one of the birds whilst superficially resembling *T. nebularia* was in fact quite different. I was able to obtain the following notes;

A dumpy squat looking Greenshank, with a thick basal section to the bill and a short legged appearance.

Bill. Compared to accompanying Greenshank (*T. nebularia*) the bill was very much thicker, being approximately 2-3 mm at its base; thereby giving the head a more solid appearance. Coloration quite marked i.e., two tone, with basal half being a dirty yellow colour with the tip section being a very dark brown or black. The bill was quite distinctly different from the other birds. Bill up-turned as per *T. nebularia.*

Legs. Appeared shorter than those of the accompanying Greenshank (*T. nebularia*) thereby giving an overall dumpy appearance. The distance of the tibio-tarsal joint from the belly seemed longer and thus, the tarsus seemed shorter than that of *T. nebularia.* The leg coloration was a clear yellow and not greenish as on the associated birds.

Size. Appeared slightly smaller than the other birds, and certainly less elegant. Body length seemed slightly shorter.

Plumage. All birds exhibited coverts with broad buffish fringes with a dark brownish central vane. The primaries of all birds seemed slightly worn. Thus, all the birds were identified as juveniles, however, the breast markings of the individual were more streaked rather than spotted. The tail appeared to have less barring on it than the Greenshank (*T. nebularia*) however, this was only seen briefly whilst the bird flew away.

General notes. The bird was seen for approximately five minutes at a minimum range of 30 ft and a maximum range of 250+ft. Light conditions were favourable and good visibility was obtained using Leitz Trinovid 10 × 40 binoculars.

On departure the flight of the bird seemed slightly more laboured and less of the legs could be seen. No call was given.

Although this bird was seen relatively briefly it is suggested that it was a Nordmann's Greenshank (*Tringa guttifer*) in juvenile plumage. It was markedly different from the accompanying common Greenshank (*T. nebularia*) If this is correct then this would be the first record of Nordmann's Greenshank (*T. guttifer*) for Nepal.

A. J. DEL-NEVO

WARDEN,
CALF OF MAN BIRD OBSERVATORY,
ISLE OF MAN,
U.K.,
November 3, 1982.

13. UNUSUAL COMMUNAL NEST-FEEDING IN SOUTHERN SMALL MINIVET *PERICROCOTUS CINNAMOMEUS CINNAMOMEUS* LINNE

The WWF-I, Nature Leadership Camp at N.D.A., Pune from the 20th to the 25th of September 1982 coincided with the nesting season of many birds in the vicinity. During this period, while leading the participants on nature trails, I observed the nests of the Yellowcheeked tit (*Parus xanthogenys*), Whitebellied minivet (*Pericrocotus erythropygius*), Redvented bulbul (*Pycnonotus cafer*), Tailor bird (*Orthotomus sutorius*), Rain quail (*Coturnix coromandelica*), Baya weaver bird (*Ploceus philippinus*), Spotted munia (*Lonchura punctulata*), Tickell's flowerpecker (*Dicaeum erythrorhynchos*) and Small minivet (*Pericrocotus cinnamomeus*).

On the 24th of September 1982 at 9.35 a.m. while photographing the nest of the Small minivet (*Pericrocotus cinnamomeus*), I made an unusual observation which I think is worthy of mention. This nest was located on a teak tree (*Tectona grandis*) at Peacock Bay of Khadakwasla lake. The tree was on the embankment of the road about seven metres high and the nest was at about four metres height from ground level, thus, well protected, though near the road. The tiny fibre cup nest was welded on to the upper surface of a branch and was almost invisible as it merged with the tree like a knot on the branch.

There were three chicks in the nest as I could see them peeping out when the adult birds alighted on the tree. Initially I saw a female feeding the chicks with a caterpillar, while an adult male alighted on the tree with an insect in its beak. As soon as the female moved aside, the male approached the nest and fed the chicks. After a short while the pair moved away from the nest. Four minutes later, I saw a pair of adult males coming to the tree with insects in their beaks. Very soon, both the males, one after the other, fed the chicks in the nest. Almost at the same time another adult male attracted my attention with a *chit—chit* call from a nearby tree. Immediately after departure of the two males, a third male also arrived at the nest and fed the chicks with an insect. I began to suspect that the nest was in possession of more than two birds and continuing my observations with interest I found that one light coloured female and four brightly coloured males, singly or in pairs, were feeding the chicks at an average interval of 3½ minutes. I continued observation till 11.00 a.m. and saw the birds feeding the chicks with caterpillars, insects and spiders and twice, just to confirm my suspicion, all the birds — one female and four adult males arrived at the tree simultaneously and fed the chicks one after the other. This behaviour has been described for the Jungle babbler — "...the four adults were all queued up like a line of waiters bringing dishes to a group of diners." (Macdonald, *J. Bombay nat. Hist. Soc.* 56: 132).

An hour later, I brought a few camp participants to the site and showed them the strange communal activity of the small minivets. Once again I confirmed that the nest was in possession of five birds — one female and four males.

The small minivet has been consistently known to have nests in possession of three birds, two females and one male (Jesse, *The Ibis,* II, 1902: 541). Jesse however did not know whether both females take part in incubation and in rearing the young.

In 1950, K. K. Neelakantan has reported in his 'Stray bird notes from Malabar' (*J. Bom-*

bay nat. Hist. Soc. 49: 554) about the small minivets, a male and two females, sharing the labour at a nest — from building the nest to feeding the chicks. He did not say anything about sharing the duty of incubation and was not sure whether the less active female was a chick of previous brood.

ULHAS RANE

LAXMI NARAYAN BHUWAN,
G. D. AMBEKAR MARG,
BHOIWADA, PAREL,
BOMBAY-400 012,
November 26, 1982.

14. OCCURRENCE OF WHITEBREASTED LAUGHING THRUSHES (*GARRULAX JERDONI* BLYTH) IN GOA

The report on the ornithological survey of Goa by Robert B. Grubh and Salim Ali (*J. Bombay nat. Hist. Soc. 73*, No. 1) refers to an "excursion... made to the top of Vagheri in Valpoi taluka, just under 1000 m, and said to be the highest hill in Goa. This was specially in order to establish whether or not the plant genus *Rubus* (brambles) and its symbiotic bird genus *Garrulax* (laughing thrushes) also occur in Goa as both do in the Kerala ranges a couple of hundred metres above this elevation. While bracken (*Pteridium* sp.) another regular member of this plant-bird association, was plentiful near the top, there was no sign of *Rubus* or *Garrulax* although otherwise the biotope seemed eminently appropriate."

I visited the forests of Goa with a few members of WWF-India, from the 6th to the 10th of April 1982. Our visit was confined to the localities of Castlerock-Dudhsagar, Molem and Mayem lake. On the 6th of April, at about 18.00 hrs, while coming back from a trek along the Kali river at Castlerock, I saw an active flock of babbler-like birds. The birds were not shy and they kept moving from tree to tree, sometimes descending to shrubs and undergrowth. Closer inspection revealed them to be Whitebreasted laughing thrushes in a flock of about 30. They were feeding on the fruits of Atki (*Maesa indica* Wall.) a medium-sized tree abundant in the evergreen forest of Castlerock and on the fruits of *Luvunga eleutherandra* Dalz., a scandent glabrous shrub common in the forest. Occasionally they would come down to the ground presumably for insects. The birds continued with their noisy feeding activity for a while and then gradually disappeared into the thick forest behind.

Next day, i.e. on the 7th of April, we trekked along railway track from Castlerock to Dudhsagar waterfall. At about 15.00 hrs, just before Dudhsagar railway station, a mixed hunting party of birds was seen in the valley to the west. The party included four Redvented bulbuls, three Yellowbrowed bulbuls, eight Jungle babblers and fourteen Whitebreasted laughing thrushes. Along with the bulbuls, the laughing thrushes were seen feeding on the fruits of Gol (*Trema orientalis* Blume), a common forest shrub. At times the thrushes were seen hunting for insects in moss-covered branches of trees and on occasion they would come to the ground along with the babblers. The party moved after sometime.

The first sighting of the Whitebreasted laughing thrushes was at Castlerock which is

in Karnataka, albeit on the boundary of Karnataka and Goa. The second sighting was at Dudhsagar (alt. about 800 m), which is well within the Goa region. These hills of Goa have luxuriant evergreen forests, a typical habitat for laughing thrushes. The region does not seem to have the well-known food plants of these birds : 1) brambles (*Rubus* sp.), and 2) hill guava (*Rhodomyrtus tomentosa* Wt.), but the other known associated plants: 1) atki (*Masea indica* Wall.), 2) gol (*Trema orientalis* Blume) and 3) bracken (*Pteridium aquilinum*) are quite common. Out of these the fruits of *Maesa indica* and *Trema orientalis* are definitely consumed by laughing thrushes, but the association of the birds with bracken (*Pteridium aquilinum*) may be related to the fact that the plant contains insect moulting hormones. This may increase the likelihood of finding insects in the vicinity of the plant.

Garrulax jerdoni has been previously recorded in the hills of Kerala and Western Tamilnadu north of the Achankovil Gap (*c.* 9°N. lat.); Cardamom, Kannan Devan and Palni hills, and High Wavy Mountains; from *c.* 1200 m to the summits. This observation confirms the occurrence of the bird also in the Goa region.

I am grateful to Mr Marcelin Almeida who helped in the identification of plants and supplied much useful information about the forests of the region.

ULHAS RANE

Laxmi Narayan Bhuwan,
G. D. Ambekar Marg,
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November 3, 1982.

15. A NEW RECORD OF SUNBIRDS AS AVIAN PESTS ON GRAPE AROUND HYDERABAD

Around Hyderabad, grape is grown in about 1000 ha. It is one of the important fruit crops and is being occasionally damaged by many species of birds causing heavy loss to the grape growers.

Perumal *et al.* (1972) recorded three species of birds visiting grape gardens in Tamil Nadu. Toor and Ramzan (1974) recorded ten species of birds causing damage to grapes in Punjab. During the survey of bird pests of grapes in February to March, 1981, we recorded 22 species of birds visiting grape orchards around Hyderabad. Among them 15 species were beneficial and 7 species harmful to the ripening berries.

Among the harmful birds two species of Sunbirds, namely Purple Sunbird, *Nectarinia asiatica* Linnaeus, and Purplerumped Sunbird *Nectarinia zeylonica* Latham, are recorded for the first time, as new avian pests damaging ripening grape berries, in grape gardens around Hyderabad. These birds pierce and puncture the berries and suck the juice making them unfit for human consumption.

The extent of damage caused by these birds was assessed in two gardens — one in Grape Research Station, Andhra Pradesh Agricultural University, Rajendranagar and another in a private orchard nearby. In these gardens 50 bunches of Anab-e-Shahi variety were examined at random to estimate the extent of damage by these birds. In each bunch, the total num-

ber of berries present and number of berries damaged by these birds were recorded. The percentage of damage ranged between 3.2 and 45. The percentage of damage was found to be more in bunches in the periphery of the garden as compared to those in the interior of the garden.

S. TEJ KUMAR
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December 10, 1982.

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16. SOME NOTES ON THE REPTILES OF THE ANDAMAN AND NICOBAR ISLANDS

The snakes of the Andaman and Nicobar islands are fairly well covered by Smith's Fauna of British India, Volume 3(1943), but the lizards have received less attention. In recent years, the Zoological Survey of India has arranged several collecting trips to various islands in that group and a paper on the last trip, which included Mr Humayun Abdulali, has already been published (Biswas & Sanyal 1980). Over the same period, Mr Abdulali, though primarily interested in birds, has also made small collections of reptiles for the Bombay Natural History Society in the course of his several tirps. The present notes refer mainly to the specimens collected during his last trip to the Andamans and Nicobars in March/April 1976, which I have had the opportunity of examining[1]. The earlier specimens referred to were identified at the Bombay Natural History Society and the notes other than taxonomic are by Mr. Abdulali. Another small collection of Dr K. K. Tiwari collected in 1977 from Andaman and Nicobar has been also examined.

The first figure is the serial number in Smith's fauna of british india and the volume and page number are also quoted. The measurements are in millimetres.

Family Emydidae

9. **Cuora amboinensis** (Daudin) (Type: island of Amboyna). Malay Box-tortoise Smith 1 : 84.

1 ex. Car Nicobar

Collector's No. CN 34. Carapace length 48, breadth 42, plastron length 41.

[1] The delay in submission is due to Mr Abdulali's inability to examine the earlier material collected by him and to include it here — Author's note at the instance of Mr Abdulali.

This was found preserved in a school museum at Mus, Car Nicobar, and Mr Abdulali was assured by the Headmaster, Mr Godfrey Lambert, that it had been locally obtained. This is the first record from Car Nicobar, though one young specimen obtained on Great Nicobar in 1966 is in the Zoological Survey Collection (Biswas & Sanyal 1977).

Family GEKKONIDAE

25. **Gymnodactylus rubidus** (Blyth) (Andaman Islands) Smith 2 : 54.

1 ex. Campbell Bay, Great Nicobar. Col. No. GN 89.

11 specimens were obtained on earlier trips to the Andamans, as also on Car Nicobar, and at Campbell Bay, Great Nicobar, but no record of its occurrence in the Nicobar appears to have been published[2]. The specimen is a male with the longitudinal prenal groove well developed. The reddish and/or light chocolate transverse bars on the body though diffused and irregular can be distinctly seen. The two postanal pores on each side at the base of tail, as figured by Smith (1935) are well developed and prominent.

65. **Hemidactylus frenatus** Schlegel (Java) 2 : 95.

4 ex. Car Nicobar. Col. Nos. CN 10, 11, 16, 23. 1 ex. Camorta. Col. No. C 30. 1 ex. Campbell Bay, Great Nicobar. Col. No. CB 79. 1 ex. Port Blair, South Andaman, Col. No. 9.

In two specimens the tails are regenerated and lack the enlarged pointed tubercles otherwise present.

The species is widely distributed over Indo-China, Malaysia and Australasia. In India it has been recorded from Bengal and is the common gecko in southern India; also Ceylon; as far west as East Africa and on St. Helena.

It has not been recorded before from Great Nicobar. At Port Blair, both pale and dark coloured individuals were noted, perhaps more of the former. Common in houses and in trees at Port Blair, and in other places in South and Middle Andamans.

76. **Gekko gecko** (Linnaeus) ("Habitat in Indiis") 2 : 111.

1 ex. Campbell Bay, Great Nicobar, Col. No. 78.

A dried-up individual was found stuck on a barrel of tar by the roadside. A detailed examination is not possible but it differs from the specimens from the Andamans in the rostral not touching the nostril, having 5 or less small scales longitudinally arranged between two lines of tubercles along the body, and with more than six small scales in each annulus of the tail.

G. gecko is known in Burma for its very distinctive call tuktoo heard over long distances. This all has not yet been recorded from the Andaman or Nicobar Islands.

77. **Gekko smithi** Gray (Type locality Penang). 2 : 113.

1 ex. in forest near Port Blair, Andamans. Col. No. 84, obtained on 12 April, 1976. 1 ex. Wrightmyo, South Andaman; collector K. K. Tiwari on 21st April, 1977. 2 ex. Campbell Bay, Great Nicobar, Collector K. K. Tiwari 26830, March, 1977.

This specimen as well as the earlier ones from the Andamans in B. N. H. S. collection have the rostral touching the nostril, and do not agree with the key to species in Smith's FAUNA. The material available does not permit any definite conclusions, but if it should be found to be different from *smithi*, Tytler's name *verreauxi* (JASB 33, 1865, p. 546) from Andamans is available.

According to Tytler the cry is a loud "*tuk,*

[2] After completion of this paper one was recorded from Great Nicobar (1980, Biswas & Sanyal, p. 258).

tuk, tuk", repeated five or six times, while Abdulali on an earlier trip to Great Nicobar recorded a gecko call as "A slow deep *truk truk truk* changing into a rapid *tuk tuk tuk* with many variations" (*J. Bombay nat. Hist. Soc. 64* (2): 142), which he said was similar to that notes for this species in the Andamans. He also noted another gecko call at night as a loud bird-like "*tk-chr-rr-rr*" and in March 1977 a similar call was noted in Great Nicobar.

81. **Ptychozoon kuhli** Stejneger (Ramri Island off Arakan Coast) 2 : 117.

Col. No. C 32. Camorta, Central Nicobar.

On wall of a shed in jungle in Camorta in daylight. Not green in colour but various shades of grey as in *Hemidactylus* sp. and very cryptically coloured.

On 25 March 1976, in heavy forest in Car Nicobar, the vertical trunk of a tree, about 18 inches from ground showed two eggs stuck to the surface close together with traces of two other pairs and a single egg, all forming a cluster within a few inches. The pair of intact eggs were white and showed dark inside, presumably developing. Each hemispherical egg had a flat circular base 15.5 mm in diameter but only 10.6 mm high. Adults were not seen but the eggs agreed well with the recorded description (Tiwari, *J. Bombay nat. Hist. Soc. 58* (2) : 523-527). The other eggs of which marks were visible may have been of the same or other individuals.

83. **Phelsuma andamanense** Blyth (Andaman Islands) 2 : 121.

One was obtained on Narcondam earlier and Rex Pimento, the Society's assistant, obtained several on Sopari-palms in a garden at Port Blair during the day, in April, 1976.

107. **Goniocephalus subcristatus** (Blyth) (Port Blair, Andamans) 2 : 163.

7 ex. Car Nicobar. Col. Nos. CN 1, 18-21, 26, 5 ex. Little Andamans. Col. No. LA 4-8.

There is considerable variation in colour and pattern which cannot be linked with size or sex, except that the young are more brightly coloured. The collector thought that those from Little Andaman were of two species. Though Stoliczka is quoted in the FAUNA (1935, p. 164) as indicating that they were 20 or 30 feet up a tree, all were obtained on the ground and on tree trunks within 5 feet of the ground.

Two of the females from among 5 specimens obtained in the Andamans earlier contained two eggs each. It has also been recorded as *G. humei* of Tillinchang in Central Nicobar by Kloss (1903, p. 67). The species is common and widespread and specimens were obtained on the small island of Battye Malve, south of Car Nicobar.

124. **Calotes cristatellus** (Kuhl) (type locality unknown) 2 : 184.

2 ex. Car Nicobar. Col. No. CN 3 and 26.

One with white stripes down its sides was obtained in a coconut grove on 26 March, 1976.

Smith (1935) gives its distribution as over a scattered area and refers to a specimen from Great Nicobar in the Zoological Museum at Copenhagen. Though *Pseudocalotes archiducissae,* of which the type is lost and which is synonymised with this species, was described by Fitzinger from the Nicobars; the present specimens are presumably the first definite records from Car Nicobar.

126. **Calotes jubatus** (Dum. & Bib.) (Java).

There is a specimen in BNHS collection obtained by J. C. Anderson in Nicobar but with no additional data. One was obtained by Zoological Survey of India at Camorta, Middle Andamans 1970 (Biswas & Sanyal 1980).

Calotes danieli Tiwari & Biswas (Campbell Bay, Great Nicobar).

2 ex. Great Nicobar. Col. Nos. GN 82 & 83.

This was described (Tiwari, K. K. & Biswas, S., 1973) on a single specimen and the present specimens confirm the differences noted. In addition, the present opportunity of comparing them with *Calotes cristatellus* reveals some more points of difference.

In *danieli* the nuchal crest is not so well developed and prominent as in *cristatellus* in which the spines, usually 9, are large, compressed and dagger-shaped, whereas in *danieli* they are small triangular, compressed and erect, these scales numbering 12-14. The supra-ocular scales are large and flat without keel or carina. On the other hand in *cristatellus* these scales are smaller, narrow and with keels. The range of scales round the body is 68 to 71. The tail is a little more than three times the body length.

In life the body colour is brilliantly green or bluish green but it changes into brown or dark brown after preservation. The characteristic patch between eye and the tympanum with a white spot in the middle remains unchanged.

Following are the measurements (in mm) and scale counts of the three specimens, one holotype and two topotyes: (Table 1).

TABLE 1

Zoological Survey of India Reg. No. 22455

Registration number	Holotype	GN 83	GN 82
Head length/breadth	22/11.5	22/11	21/11.5
Snout to vent	79	80	72
Axilla to groin	43	43	41
Vent to tip of tail	271	198+?	254
Fore limb	43	43	44
Hind limb	71	80	74
Scales round body	71	69	68
Spines of nuchal crest	12	14	12

One of the specimens was rescued from a domestic hen when it was noted to be mud brown all over and with black below the eye. The collectors Rex Pimento and Cyrus Toorkey are positive that this was not due to earth or other substance but that it became green before insertion into formalin.

179. **Mabuya multifasciata** (Kuhl).

3 ex. Car Nicobar. Col. Nos. CN 2, 17 & 24.

The three specimens have 33 and 34 scales round the body and 19 lamellae under the fourth toe.

One was obtained on Pandanus roots and a field note states that it appeared to climb up coconut palms. One had yellow under the chin

179a. **Mabuya rudis** Boulenger

Mabuya rudis Boulenger, Cat. Lizards. Brit. Mus. 3 : 188. 1 ex. Campbell Bay, Great Nicobar. Col. No. 80.

Smith (1935, p. 369) had suggested that this should be a subspecies of *M. multifasciata* but the following differences indicate a different species. (Table 2).

Some more differentiating characters are noticed after comparing the specimen with three specimens of the collection assigned to

TABLE 2

M. multifasciata	*M. rudis*
1. Hind limb not reaching axilla.	1. Hind limb reaching the axilla or beyond.
2. Subdigital lamellae smooth.	2. Subdigital lamellae keeled.
3. 30 to 34 scales round the body dorsal 3 rarely 5 keeled, lateral quite smooth.	3. 30 to 36 scales round body, dorsal and laterals strongly keeled.

multifasciata. Anterior border of the tympanum of the specimen referred to the present species is without larger projecting lobules but granular lobules instead round the border of tympanum. In the specimens belonging to *multifasciata*, there are 1 to 3 enlarged lobules in the anterior border. The scales from tympanum to the forelimb are comparatively very small and these are very prominently keeled as also the parietals and nuchals of the head shield. In *rudis* the 6th upper labial is the largest and the first lower labial is nearly equal to the 2nd but in the specimens of *multifasciata* the 5th upper (4th in one) labial is the largest and the 1st lower labial is smallest.

The body coloration is dark and a whitish line is there from lower border of eye to the tympanum. Following are the measurements (in mm) of the specimen and one of *multifasciata*: (Table 3).

TABLE 3

	M. multifasciata	*M. rudis*
Snout to vent	117	47
Tail	155	97
Head length (snout to tympanum)	24.9	12
Head width	19.2	8.5
Axilla to groin	57	23
Fore limb	46	20
Hind limb	65	29
Scales round the body	33	30

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Remarks. As this longlegged form occurs occasionally from widely separated parts of the Malay Archipelago, therefore according to Smith (1927) the name applied to a geographical race in its strict sense cannot be used but he had also objections to placing the specimens having the above mentioned characters under the species *rudis* as he thought intermediate examples between *rudis* and *multifasciata* were available. Unless it is definitely proved so the present species stands.

Family COLUBRIDAE

Xenochrophis piscator melanzostus (Boie)

2 ex. Campbell Bay, Great Nicobar, collector K. K. Tiwari on 8th April, 1977. 1 ex. Wrightmyo, S. Andaman, collector K. K. Tiwari in April, 1977.

So far this subspecies was known to occur only in Andaman but the present record extends its distribution further to the south in the Great Nicobar and it also very closely resembles the colour form of the *X. piscator* occurring in the Malay Penninsula (Smith 1943).

ACKNOWLEDGEMENTS

I thank the Director, Zoological Survey of India for facilities to work out the collections and I am particularly indebted to Mr Humayun Abdulali, a well-known naturalist of Bombay for allowing me to examine his small but valuable collection. His field observations add to the value of this note.

S. BISWAS

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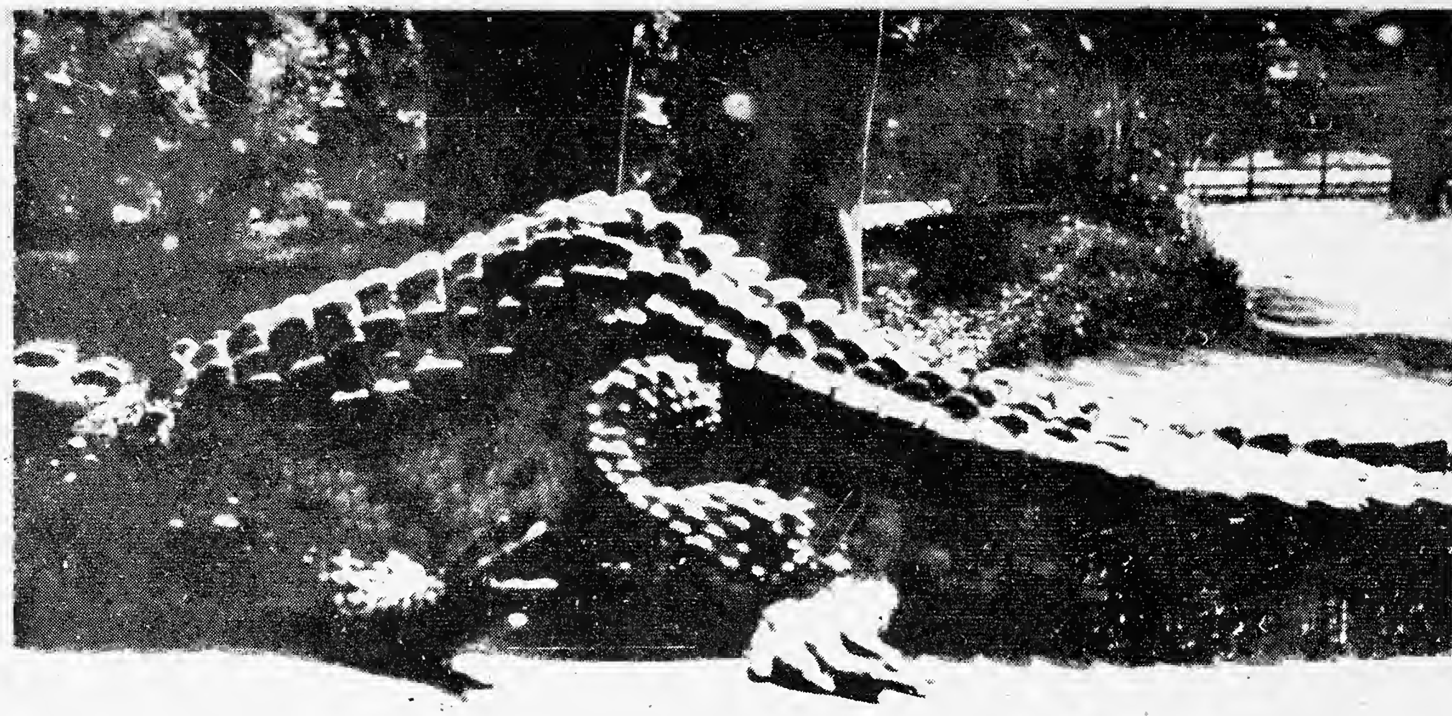

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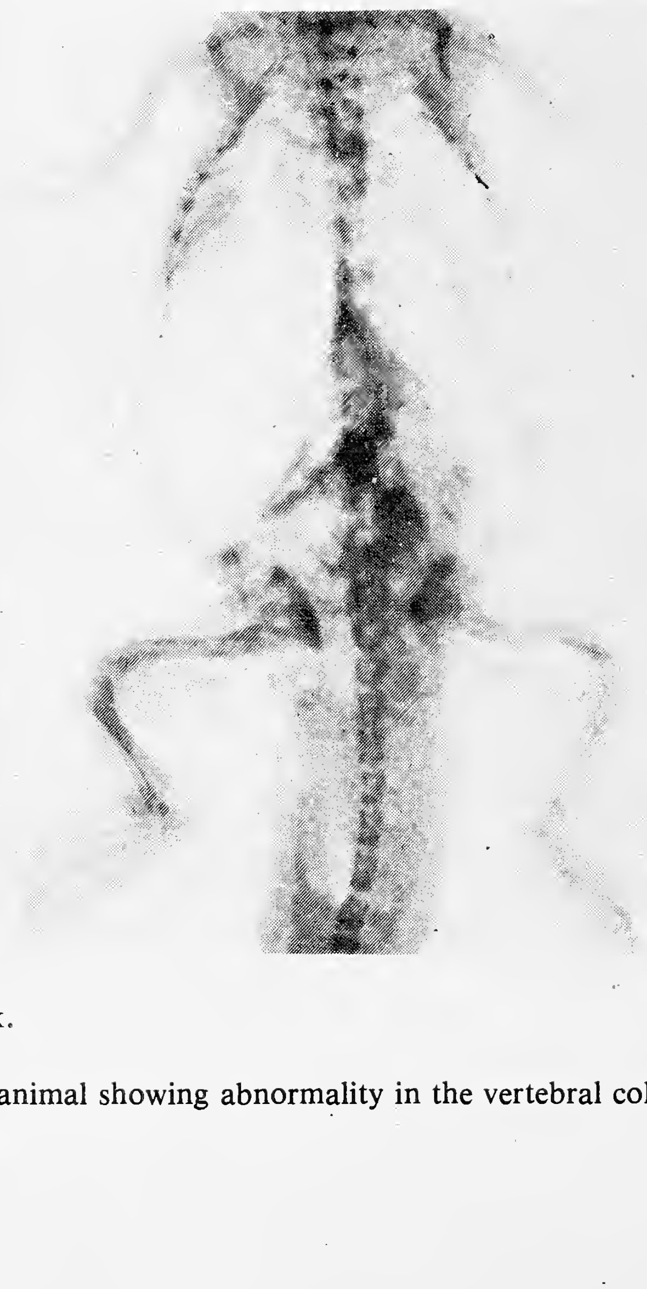

3

Above: Fig. 1. An affected crocodile with hunchback.
Below: Fig. 2. Radiograph of a normal specimen.
Fig. 3. Radiograph of the calcium defficient animal showing abnormality in the vertebral column and pelvic girdle.

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17. NUTRITIONAL DISORDERS OF YOUNG CAPTIVE CROCODILES

(*With a plate*)

The female of a pair of mugger crocodile, *Crocodylus palustris* kept for exhibition at Indira Gandhi Zoological Park, Visakhapatnam has been laying eggs successfully since 1977. The eggs laid were allowed to hatch *in situ* in the enclosure every year, but the hatchlings were removed from the parents for separate rearing in specially designed rearing pools.

During the rearing of the young, it has been noticed that most of the hatchlings of the age group 0-2 years which are fed with lean beef meat alone are being affected with the cessation of the growth succeeded by hunchback (Plate I; 1) and death follows if untreated. This has been proved as a nutritional disorder and the symptoms are as follows.

(1) Appearance of hunchback between pectoral and pelvic girdle progressing from the eigth lumbar vertebra towards pelvic region.

(2) Poor appetite and sluggish movements.

(3) Increase of hunchback.

(4) Death due to hypoglycemia, specially on cold nights.

(5) In older animals (1-2) death due to the fracture in vertebral column.

These symptoms are found to be due to the resorption of calcium from the bones into the plasma or due to severe imbalance of calcium to phosphorus ratio, or because of low vitamin D content in the diet, as the diet of meat has a very low percentage of calcium. The abnormalities in the vertebral column and pelvic region are clearly shown in the radiograph (Plate I; 3) of calcium deficient animal. The difference between normal crocodile and affected can clearly be seen in the radiographs (Plate I; 2 and 3). The mortality occurs within 15-20 days after the onset of the symptoms in case of 2-5 months old hatchlings. Whereas in the case of yearlings the cessation of growth is clearly noticed and subsequently death follows.

It has been established that the crocodiles in captive rearing suffer from this common nutritional disorder due to feeding with imbalanced diet. The lean beef with which the crocodiles are fed with, generally has a low calcium and vitamin D content.

In an attempt to prevent this death of hatchlings (below one year age), several combinations of diet were given to the reptiles. They are crabs, fish, liver, beef etc., and finally it has been found out that the best suited diet for hatchlings should be the combination of beef, liver and crabs on one day, alternate with beef, liver and fish on the second day but for yearlings (1-2 years age) beef, liver, fish

and crabs should be given every day. It is advisable to administer the diet in the following proportions (Tables I and II).

TABLE I

DIET FOR HATCHLINGS

Diet	Quantity	
i) Beef	250	Per
ii) Liver	50	twelve
iii) Fish/crabs	150	hatchlings

TABLE II

DIET FOR YEARLINGS

Diet	Quantity	
i) Beef	450	
ii) Liver	100	Per
iii) Fish	100	twelve
iv) Crabs	100	yearlings

The success of survival after administration of this balanced diet may be seen from Table III.

TABLE III

SURVIVAL OF CROCODILES WITH AND WITHOUT BALANCED DIET

Year	No. of hatchlings	Mortality due to nutritional disorder	No. of survivals	Survival (%)	Diet
1978	15	13	2	13.3	Not balanced
1979	16	15	1	6.2	Not balanced
1980	14	4	10	71.4	Balanced
1981	27	Nil	27	100.0	Balanced

The hunchback in case of yearlings, however, persists even after the change of diet though the disease no longer remains.

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We wish to express our thanks to Sri Pushp Kumar, I.F.S. Conservator of Forests, Wild Life Management, Andhra Pradesh, Hyderabad for his encouragement and guidance.

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Above: Two headed earth-snake *Eryx conicus*.

Below: Two headed earth-snake *Eryx conicus*. X-ray photograph of the anterior portion of the body, showing two separate skulls and portions of the vertebral columns.

18. A REPORT ON THE RARE OCCURRENCE OF TWO HEADED RUSSELL'S EARTH-SNAKE OR RED EARTH BOA *ERYX CONICUS* (OPHIDIA: BOIDAE)

(*With a plate*)

Earth snake or Russell's Sand Boa *Eryx conicus* is a sluggish and shy snake common in the dry arid zones of northeastern parts of Karnataka State. An unusual specimen of *Eryx conicus* with two heads was collected by a farmer of the village Hole-Alur (Dist. Dharwar; Karnataka State) on 4th June, 1983 and was handed over to Shri M. V. Waddin., Asst. Conservator of Forests, Dharwar Division, Dharwar. The specimen was maintained alive for two months being fed with earthworms, grubs, etc. Through the courtesy of Shri Waddin it was possible to bring the specimen to the Zoology Department and make some observations on it, which are as follows:

The specimen is uniformly elongate, showing no constriction between the head and trunk. It measures 200 mm long and 40 mm in girth in the trunk region (Plate I). The animal has two separate heads and both are of the same size. Further, as the X-ray photograph reveals, the vertebral columns following the heads are separate for some distance (Plate I).

The movements of the snake were slow and sluggish. When the animal was moving in a particular direction, only one head used to lead and the other used to trail. On disturbing the snake and making it to change the direction, the other head used to lead while the first one trailed. The bifid tongue from each of the mouths was seen quivering in and out of the month. As we observed, the twin brains smoothly co-operated and co-ordinated with each other to make the animal feel "functionally single headed".

This freak specimen may be regarded as an instance of monstrosity. There are some reports from countries other than India, on the double-headed snakes such as rattle snake *Crotalus* sp., the king snake *Lampropeltis getulus* (Fam: Colubridae) and the garter snake *Thamnophis* sp. From India such a feature has been observed in the snakes such as the wolf snake *Lycodon aulicus*[1], Cobra *Naja naja*[2], Russell's viper *Vipera russellii*[3] and Water snake *Xenochrophis piscator*[4] and in the water snake *Cerberus rhynchops*[5] (Whitaker 1971). The present report on the double-headed snake of the genus *Eryx* is the first of its kind.

The specimen has been displayed in the Museum of our Department. Sincere thanks are due to Shri M. V. Waddin, Asst. Conservator of Forests, Dharwar Division, Dharwar, for readily donating this rare specimen to me for study and preservation in the College Museum.

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19. PREDATION ON A SYMPATRIC SPECIES BY *HEMIDACTYLUS LESCHENAULTI* (SAURIA: GEKKONIDAE)

The tree gecko *Hemidactylus leschenaulti* is sympatric with *H. frenatus* (the common house gecko in south India) in houses in urban and suburban areas. The former is the larger species averaging 166 mm in total length (snout-vent: 83 mm), the latter has a total length of 125 mm (snout-vent : 60 mm) (Smith 1935). Both species are territorial, predominantly nocturnal, feed primarily on insects and have identical hiding place preferences. The incident reported here occurred in a dimly lit room in my house in Madras city, South India. Hiding places for geckos in the 3 m square room are few and restricted mainly to the 1 m long gap behind the metal frame of the tubelight in the room. The gecko population in the room consisted of one adult pair of *H. leschenaulti. H. frenatus* although present in adjacent rooms was conspicuously absent, no doubt due to the presence of the larger tree gecko.

At 14.30 hours on 10th February, 1983 an adult *H. frenatus* (HF) (sex unknown) was seen moving away from the tubelight at a distance of 1 metre. It was noticed also by one of the resident *H. leschenaulti* (HL)) from its hiding place behind the tubelight resulting in a short chase which ended about 2 metres from the light, with HL seizing HF violently at midbody, inflicting a deep wound. HF retaliated by seizing the side of HL's lower jaw. HL then released its grip on HF's midbody seizing the head instead, and, after a brief pause, commenced swallowing the faintly struggling HF. HL then returned to its hiding place. The entire sequence of events took approximately 4 minutes. It is suggested that HL is an aggressive predator and opportunistic feeder and that the gradual disappearance or decline in numbers of the smaller house geckos following the colonisation of an area by HL may be a result of predation (Whitaker, R. *pers. comm.* and personal observations). The food habits of *H. leschenaulti* is poorly documented and the only other published account of this gecko feeding on vertebrate prey is that of Sumithran (1982).

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20. ON THE DISTRIBUTION AND HABITAT OF THE HIMALAYAN NEWT (*TYLOTOTRITON VERRUCOSUS* ANDERSON) IN THE EASTERN NEPAL

(*With a plate*)

A detailed account of the Himalayan newt belonging to the genus *Tylototriton* (Caudata: Salmandroidea) was published by Anderson (1871), which was based on a collection from western Yunan. Annandale (1908) was the first to record the breeding habit of the Himalayan newt. Smith (1924) described the tadpoles and Chaudhari (1966) studied the habits and behaviour.

Soman (1966) reported the newt from the Dingla (Nepal) and made a brief comment on the eastern distribution of the newt. Further, Mansukhani *et al.* (1976) recorded the newt from the Arunachal Pradesh of India. Recently, the generic status of the *Tylototriton* has been reviewed by Nussbaum and Brodie (1982). The present find from various localities of eastern Nepal is of considerable significance for it extends the known range of distribution of the species further westward and throws light on the ecology of the newt.

While studying the aquatic vertebrate fauna of the rock pools along the hills of the eastern Nepal, five examples of the Himalayan newt of the genus *Tylototriton* measuring from 130 to 200 mm (Table 1) were collected and have been identified as *Tylototriton verrucosus*. There being no detailed previous record on the Newt from eastern Nepal so far, the present report on the urodel from different areas is an attempt to provide information on the distribution and habitat.

TABLE 1

MEASUREMENT OF *Tylototriton verrucosus* ANDERSON

Total Length	137.0	170.0	200.0	166.0	130.0
Head Length	13.2	20.0	26.0	20.0	18.0
Width	15.2	20.0	21.6	19.0	16.0
Interorbital	8.0	9.0	10.0	8.0	8.0
Internasal	6.0	6.0	7.0	6.0	6.0
Orbit	4.0	4.0	4.0	3.0	3.0
Snout to gular fold	15.0	21.0	22.0	20.0	17.0
Gular fold to vent	43.5	70.0	75.0	52.0	52.0
Axilla to groin	33.6	50.0	55.0	40.0	32.6
Tail Length	65.0	85.0	95.0	82.0	81.0
Length of forelimb	20.0	26.2	29.0	26.0	28.0
Length of hindlimb	21.6	26.4	30.0	28.0	27.0

Material Examined 5 Examples. Chulachuli hills, lat. 26°55′, long. 87°55′, 1900 m. Mai river valley, lat. 26°55′, long. 87°20′, 1300 m. Hilae Dhankuta, lat. 26°59′, and long. 87°21′. Maipokhari (Ilam), lat. 26°55′, long 87°54′, 1300 m. One of the specimen has been deposited in the British Museum and rest are deposited in the Zoological Museum, Tribhuvan University, Kirtipur Campus.

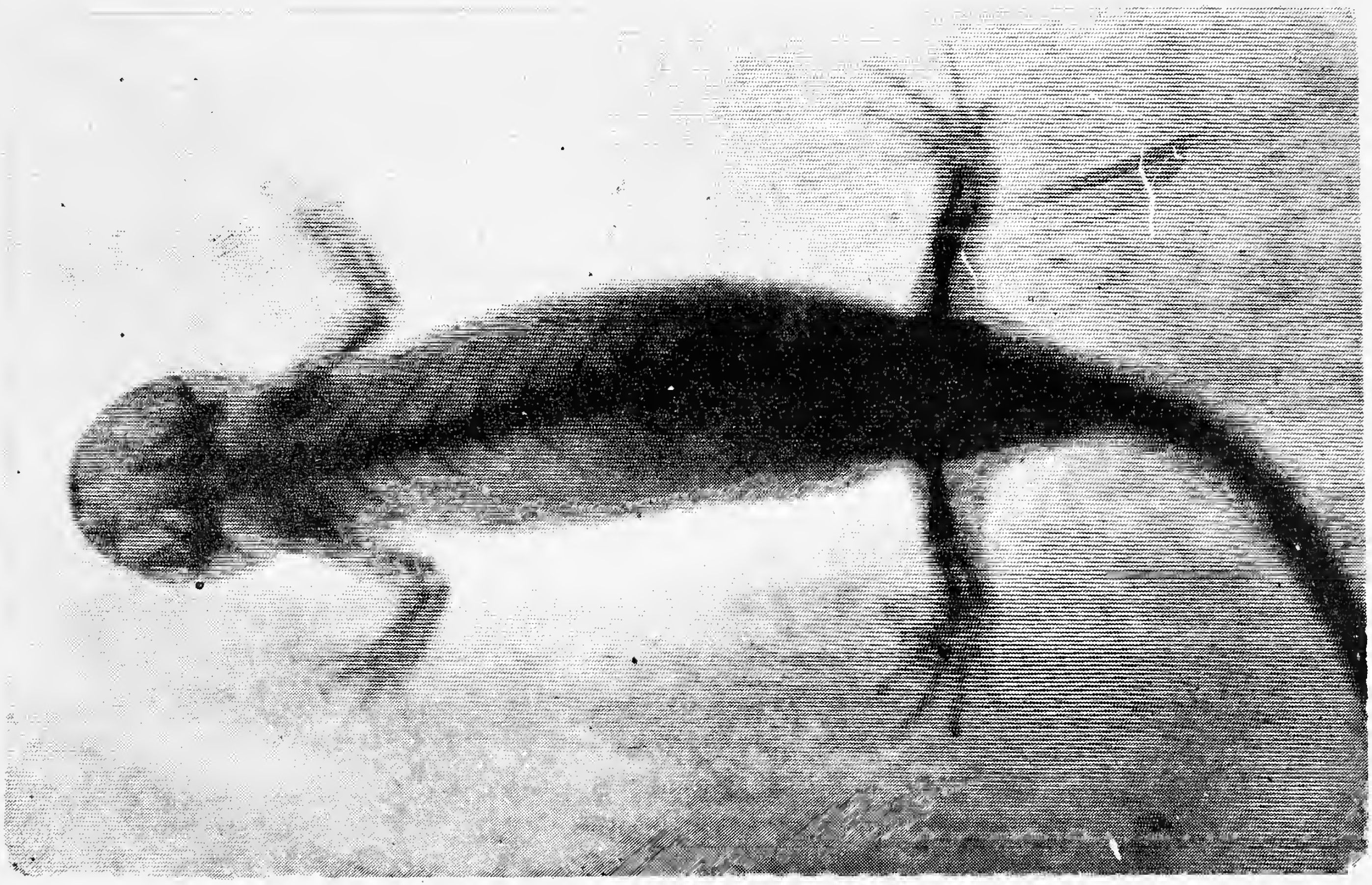
Palatine series of teeth forming a $\wedge$, commencing on a line with, or a little in front of, the choanae. Head somewhere broader than long, surrounded by a distinct osseous porous ridge, a short similar ridge along the parietals, snout short, broad, eyes moderate, no labial lobes. Body 3 to 3.5 times the length of the head, no dorsal crest, but a broad prominent porous vertebral ridge, produced by the great development and transverse expansion of the neural processes of the dorsal vertebrae a series of 15 or 16 knob-like porous glands along the side,

the last three behind the leg when it is extended at right angles to the body. Limbs moderate, fingers and toes free, depressed. Tail as long as head lower crest, ending in a point. Anal opening a longitudinal slit, the borders not much swollen. Skin tubercular, parotoids large, very distinct, a strong gular fold. Colour. Uni form blackish brown, paler on the lips, snout, chin, throat, and under surface of limbs, lower of tail orange-yellow. (Body measurements are given in the Table 1; Plate I).

The newt occurs in the upland pools of the Chulachuli hills. As such the water quality of the pools varies from time to time and sometimes becomes highly acidic (pH4 to 6) during the late spring (April-May). The oxygen concentration varies from 5 to 10 ppm and temperature ranges from 15° to 25°C. During the rainy season the newt inhabits shallow, recently flooded rock pools, rice fields and boulder strewn creeks flanking the course of the Mai river and Rautae khola (hill stream). Lurking in the crevices between large, partially submerged boulders it shares its niche with typical mountain brook hylid and rhacophorid frogs as well as many a genera of the aquatic insects such as *Belostoma, Rantara, Perla* and *Ephimera* and *Anax.* During the night the newts leave their shelter and move about actively. They also wander far from the water holes and water loaches. The newt is an excellent example of camouflage and concealment and is rather difficult to locate in the pond as it blends perfectly with water weeds. They are encountered through rainy season but more frequently in premonsoon rainy days (May and June), which is appearently their breeding season. The chief food of newt appears to be zoo-benthos, mushrooms, aquatic insects and tadpoles. The newts lead a terrestrial life during the cold days of the winter and lie sheltered under a decaying log or wood near water. On two occasions I collected hibernating newts during the month of December. They showed very little movement on handling. There was no water hole near the hibernating dens. During December the atmospheric temperature ranges from 9° to 15°C. Probably the newt emerges out of the hibernation dens after the first rains in the spring and breeds in the pools formed in the latter part of the spring (April to May).

In Nepal the Himalayan newt is known as *Pani kukur* (Water Dog) and *long-ling* (animal with a long tail). The dried and smoked preparation of newt is used by witch doctors as a cure for typhoid and gastric ailments. Newts are susceptible to water pollution and complete ban of detergents should be made in newt habitat. The Himalayan newt is on the verge of extinction in Nepal and is scarcely available for detailed study.

The newt has been reported from various places in Asia. For example, Anderson (1871) recorded it from Yunan and China, Kakhein hills of upper Burma, Chien Deo in Northern Siam and Darjeeling, Sikkim. Smith (1924) gives an idea of its past distribution in India. According to him '*Tylototriton verrucosus* is common at certain places in Darjeeling district at altitude 4000 to 6000 ft, but is very local. I have been unable to obtain any evidence of its occurrences west of the Tista river'. But Soman (1966) reported the newt from the Dingla district of Nepal (Lat. 27°22′ and Long. 87°09′) and furnished the proof of more western distribution of the newt. My collection from various areas of east-west Nepal reveals that distribution of the newt is not so local as it was believed previously. The newt can be found far west of Tista in isolated pockets of the Siwalik and Mahabharat hills where humidity and temperature are favourable.



Above: X-ray photograph of the Himalayan Newt. Note unbranched ribs and limb structures.
Below: Newt in the Natural habitat of Mai river valley. They avoid direct sunlight at the day time.

The newt is still thriving well in the luxuriant highland forests of Chulachuli hills, Mai valley of far eastern Nepal. My find shows clearly that a great deal lies unsurveyed in that complex and in the unique highlands of Mahabharat and Siwalik hills of eastern Nepal. It is appalling to witness the environmental degradation in many of these highland aquatic ecosystems that were once lush with green plants and are now deforested, degraded and eroded today. As a result, many of the newt's breeding pools have dried up, and their larvae are stranded during the dry season. Those breeding pools that are wet and moist are polluted by DDT and agricultural insecticides. If such activities are unchecked there will be no ecological stability for the newt. The Himalayan newt from its intrinsic scientific, academic and educational interest, requires that its wetland habitat within the higher hills need to be protected for its continued survival.

ACKNOWLEDGEMENTS

I thank to Miss A.G.C. Grandison, Curator, Herpetology, British museum for providing me literature. Also I am grateful to Drs. Naussbaum and Brodie, University of Michigan and Aldephi University respectively for their advice and help.

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21. DISTRIBUTION OF *BUFO CAMORTENSIS* MANSUKHANI & SARKAR IN THE ANDAMAN AND NICOBAR ISLANDS

In 1976 Mr Humayun Abdulali obtained some toads on Camorta Island, Central Nicobars. As they appeared different in structure and habit from *Bufo melanostictus* he left them at the Zoological Survey of India, Calcutta on his way back to Bombay.

They have been included as paratypes of a new species *Bufo camortensis* based on earlier specimens obtained by Dr A. G. K. Menon of ZSI at Camorta and Nancowry by Dr (Mrs) M. R. Mansukhani and A. K. Sarkar (1980). Except for paratypes from Camorta and Nancowry, (both in Central Nicobars) there is no reference to the species being found anywhere else.

An examination of the Bombay collection, has revealed earlier specimens of this species obtained by Mr Abdulali at Wright Myo in South Andaman (9th Feb. 1964) and Great Nicobars (27th February and 3rd March 1966) which have remained listed as *Bufo melanostictus.* This re-examination reveals that this toad apparently extends throughout the length of the Andaman and Nicobar islands.

It is also interesting to note that a specimen of *Bufo melanostictus* was also obtained at Port Blair, South Andaman on the same day (9th February 1984) as *Bufo camortensis* and that these two species are not geographically isolated. It is of course possible that they occupy different habitats for though the mode of progression appeared different (Abdulali 1982), no different habitat was recorded.

To assure that there is no error in the labelling, inquiry at the ZSI reveals that they have specimens of *Bufo melanostictus* from the Andamans.

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22. THE OCCURRENCE OF THE MARBLED BALOON FROG *UPERODON SYSTOMA* (SCHNEIDER) (FAMILY MICROHYLIDAE) IN BARODA (GUJARAT STATE)

A specimen of this microhylid frog was collected from a dried out tributary of the River Vishwamitri passing through the University of Baroda campus. The coloration is

pinkish above, marbled and spotted with brown spots. Ventrally it is pale, pinkish or yellowish white.

The presence of *Uperodon systoma* in Gujarat is being recorded for the first time with my finding a specimen of this species from Baroda.

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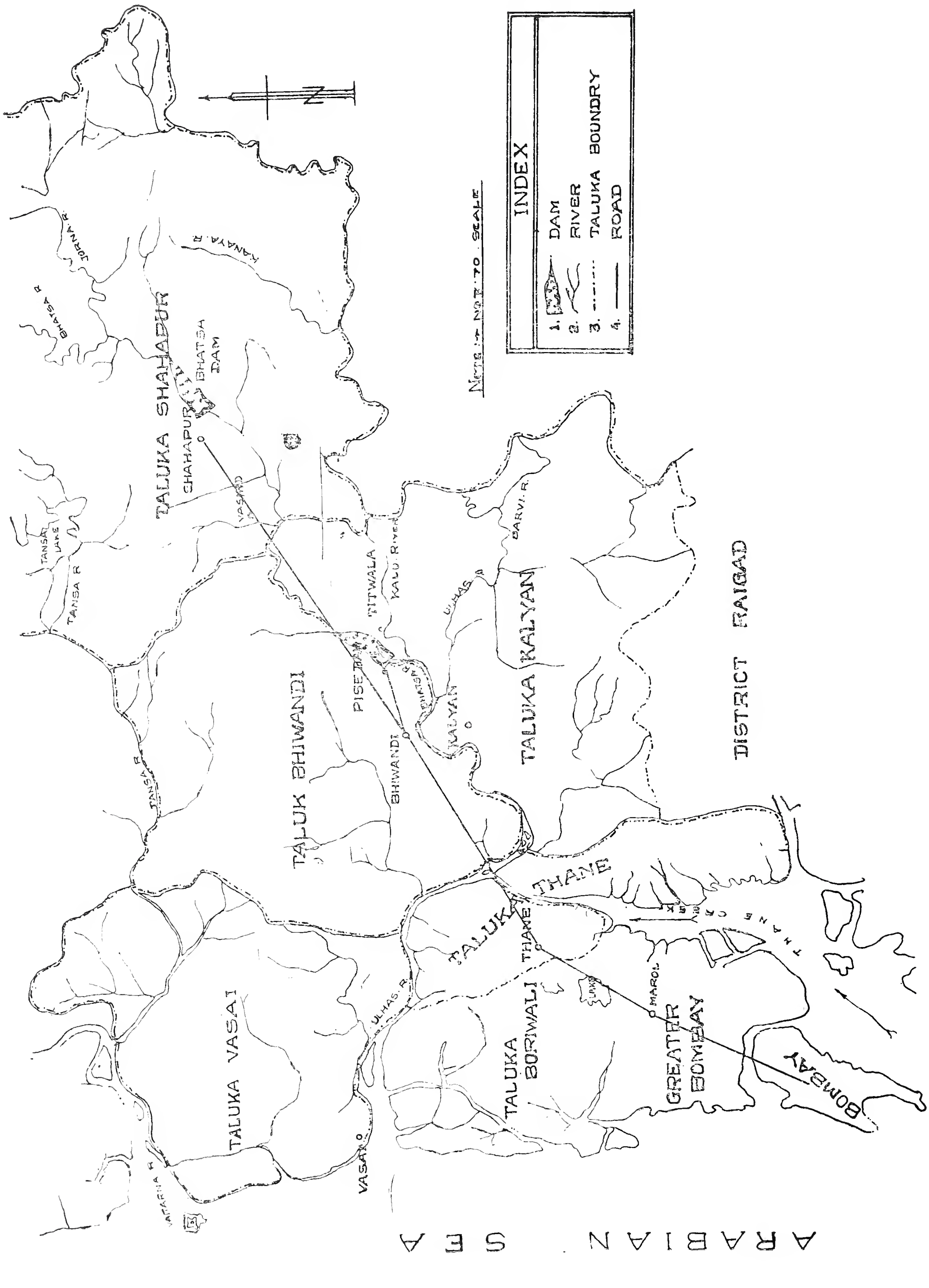
23. SOME ECOLOGICAL OBSERVATIONS LEADING TO A NEW SOURCE OF SEED OF THE FRESHWATER PRAWN *MACROBRACHIUM ROSENBERGII* (DE MAN) IN MAHARASHTRA

(*With two text-figures & a map*)

The freshwater prawns *Macrobrachium rosenbergii* and *M. malcolmsonii* constitute the jumbo prawns in India, being larger than even the largest marine prawns. As such, they are in great demand as an item of food and fetch a high price. In nature, innumerable young ones of these prawns perish due to unfavourable environment and predation. Survival of these young by collection and transplanting into suitable stretches of water is one step towards their conservation and fuller utilisation of the valuable natural resource.

A peculiar habit of these "freshwater" prawns is their requirement of sodium chloride (dilute saline water) during early stages in their life cycle. Thus, even *Macrobrachium malcolmsonii* (H. Milne-Edwards) which is found in Nanded, Chandrapur and Bhandara districts of Maharashtra, hundreds of kilometres upstream of the mouth of the river Godavari (Rajyalaxmi 1960, Ibrahim 1962), cannot reproduce successfully unless they encounter brackish water for their crucial larval stages. Once this larval development has been successfully accomplished, the young crawl laboriously upstream until they reach the fresh waters where their parents had resided. This upstream migration forms the basis of a regular prawn fishery on the River Godavari. Collection of tiny prawnlets in astronomical numbers below the anicuts like Dhavaleswaram and others and their age-old use as food is a colossal waste of our natural resources as the prawnlets, if allowed to grow to adult size, would yield much greater returns. Similar is the case of *M. rosenbergii* which occurs more predominently on the west coast of India, where the rivers being of shorter length, the prawn spends longer time in the estuarine ecosystem though its urge to go upstream remains unabated, as described hereafter. Moreover, collection of seed of *M. rosenbergii* from natural environment has not been reported so far.

Although both these prawns have been successfully bred and reared in the laboratory (Ling 1969, Kewalramani *et al.* 1971), procurement of prawn seed in large numbers still necessitates collection of the natural seed.



Map. 1. Showing location into the river Bhatsa on which seed of *Macrobrachium rosenbergii* is collected below the Pise Dam

Attempts are, therefore, being made all over India to survey water stretches to assess the availability of prawn seed. In the Thane district of Maharashtra, a potential source of seed of *M. rosenbergii* has been found just below the Pise Dam. The dam was constructed in 1979 by the Bombay Municipal Corporation as an anicut or a pick-up weir into which flows the water coming from the Bhatsa Dam, the Bhatsa river being a tributary of the Ulhas river which empties into the Arabian Sea at Bassein. (Map 1).

Towards the end of the rainy season, i.e. in September and October, post-larval young of this prawn, varying in length from 30-50 mm, abound in the stream below the dam. At this stage they develop a natural instinct to avoid estuarine environment and prefer ascent into fresh water. During the spring tides when the tidal flow is strong, wide range of fluctuation in salinity was observed below the anicut, ranging from 1 ppt to 15 ppt. The water temperature too varies from 25°C to 29°C depending upon the tidal influx. The pH recorded at the time of observation was 7.5. The brackish water caused by the incoming tidal

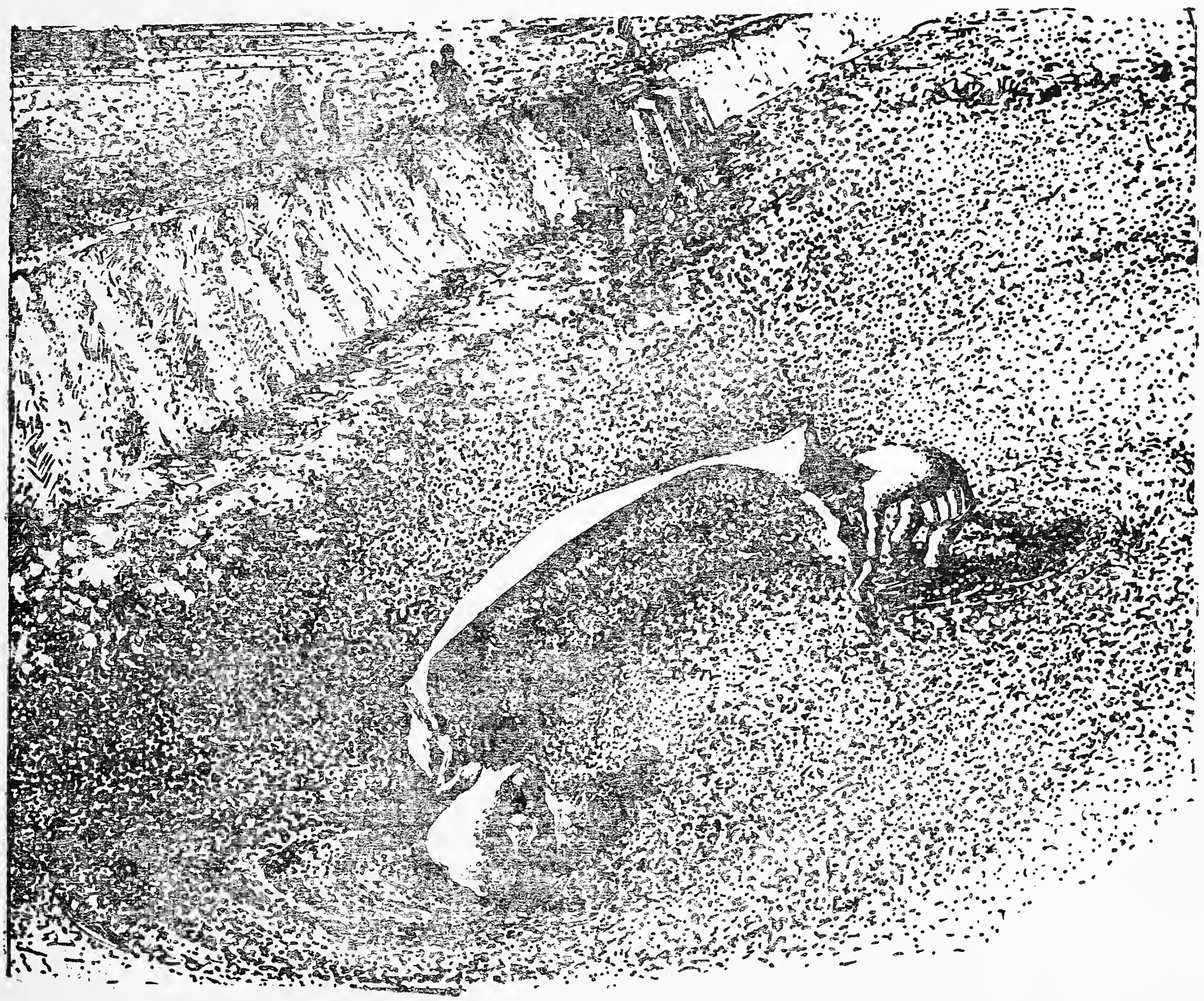


Fig. 1. Collection of *Macrobrachium rosenbergii.*

influx forces the young fry to go away from the changing environment and on approaching the anicut, to move in rows, negotiating the freshwater flow over the indented rocky edges while advancing. In some cases where their desparate bid to advance is foiled by the current, they crawl up on the wet side-rocks in thousands and cover the stones entirely. This movement is more pronounced during night and in the light of an electric torch, their eyes glow in the dark and make a spectacular sight. On other days when the quantity of tidal water entering the river is less the number of young prawns approaching the anicut is also small.

Attempts to capture the young prawns were first made in 1981, and in the preliminary attempt very few young could be caught. However, when the net was modified (Fig. 1) thousands of them literally rushed into the collecting net in a moving stream. The net was a monofilament rectangular piece, 2×1 metres, with two long bamboo poles at the extremities. The net is held by two persons who walk downstream below the dam. In the right season and time, as many as 50,000 young could be collected in half an hour. Concentration of such large numbers in a restricted stretch of water is attributed to the reluctance of the young to move through brackish water brought in by the rising tide. The young congregate near the dam in the fresh water, waiting for the ebb tide to take away the brakish water downstream when they could spread themselves into the fresh water. Collections have been repeated in subsequent years, and in the proper season have always yielded excellent catches.

The local tribal fishermen were aware of this migration and they used to trap the young prawns in cylindrical bamboo trap nets fixed in the stream with their mouth facing the current (Fig. 2). The fishermen used to catch the prawns for their own consumption or sell them in the market at a rupee for two

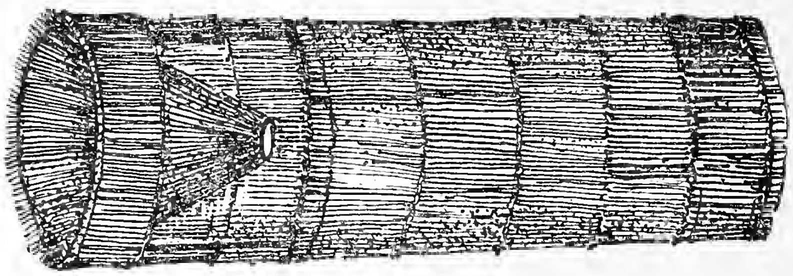


Fig. 2. The bamboo trap net used by the local fishermen.

handfuls of the prawns, i.e. some 4000-5000 prawns. However, when the collection was made systematically and the prawnlets were kept alive for prawn culture, the tribal fishermen were also benefitted as they received a more lucrative return and the prawn rearing occupation too received a significant boost.

I am grateful to Shri A. G. Kalawar, former Director of Fisheries & Fisheries Adviser to the Government of Maharashtra, Shri S. S. Naik, Director of Fisheries, Maharashtra State, and Shri S. S. Desai, Deputy Director of Fisheries (Marine), for their encouragement and guidance during the collections as well as the preparation of this Note. I am thankful to Dr. B. F. Chhapgar, Scientific Officer, Bhabha Atomic Research Centre, for associating himself with this work from the beginning and for giving constant encouragement and help. I am also thankful to my colleagues Sarvashri V. M. Sawant & T. D. Mahadik.

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24. A NOTE ON SPECIES NAMED *LYCAENA PAVANA* (LEPIDOPTERA: LYCAENIDAE)

Wynter-Blyth (1957: 301) has given the distribution of a lycaenid butterfly *Lycaena pavana* Horsfield as Kashmir to Kumaon. This is partially incorrect. There are in reality two separate species, which have been named '*Lycaena pavana*' at different periods of time.

Horsfield (1828: 77) described a small butterfly from Java and named it *Lycaena pavana.* It has a 26-28 mm wing span. Subsequently, it was recorded from Tavoy, S. Burma and Andamans, with 'not rare' status (Evans 1932). This species was brought under the genus *Nacaduba* by Wood-Mason & de Niceville in 1886 and referred to as such in the 3rd vol. of BUTTERFLIES OF INDIA, BURMA & CEYLON (de Niceville 1890: 145). Later, Corbet (1938) described a new subspecies of it from Singapore, and this *Nacaduba pavana singapura* is now considered the subspecies found in Assam, Burma, Andamans and Malaya (Cantlie 1962: 75). This species has been recently placed in the subgenus *Rapsidia* by Sibatani (1974: 109), though he wrongly gave Evans as the author of the species.

Kollar (1948: 416) in Huegel described another lycaenid butterfly as *Polyommatus pavana* from the Western Himalayas. It was published in Huegel's series, in German, on "Kashmir" Part 2 of vol. 4 meant for 1844 and appeared in 1848. This species of Kollar was transferred to genus *Chrysophanus* by Horsfield & Moore in 1857 and referred to as such by de Niceville (1890: 317). This butterfly is a little larger than the *pavana* of Horsfield, its wing span being 37-40 mm, and its range of occurrence is recorded in literature as from Kashmir to Kumaon where it is 'common' in status. Since as early as 1871 Kirby, brought this species into the genus *Lycaena,* both Evans (1932) and Cantlie (1962) have cited it as *Lycaena pavana.*

Thus, what was initially called *Lycaena pavana* is now a species of *Nacaduba,* and what was initially *Polyommatus pavana* is now referred to as *Lycaena pavana,* in well-known works on Indian butterflies.

However, on further study it was revealed that Kollar misidentified his new species as *pavana* of Horsfield, with the result that his new species had no valid name of its own. In 1852, Westwood gave it a new name as *Thecla panava* (note 'nava' in the place of 'vana'). Thus, as per nomenclature rules, Westwood's epithet is the oldest available name applied to this species and accordingly it is its valid name, now under *Lycaena.*

To conclude, at least during 1871 to 1886 there were two different species having the same name — *Lycaena pavana.* But presently both species are not called *Lycaena pavana,* as shown below. Besides it is evident that *Lycaena pavana* of Horsfield does *not* occur from Kashmir to Kumaon.

The two species may be briefly separated as follows (character details may be seen in Cantlie, 1962):

White bordered; prominent white band on underside of hindwing; female having basal half wing dark brown; Forewing length from base to apex 18.5-20 mm *Range* — Kashmir to Kumaon, Nainital, Almora, Nepal [and Garhwal: new record]; Common name — 'White—bordered Copper' ....*Lycaena panava* (Westwood)

Comparatively smaller specimens with pale violet blue wings; underside markings broad and all bands white; forewing length from base to apex 13-14 mm. *Range* — Java, Singapore, Burma, Sikkim, Bhutan, Assam and Andaman Is. Common name — 'Small Four Lineblue'.......... ....*Nacaduba pavana* (Horsfield)

ACKNOWLEDGEMENTS

Thanks are due to the Director, Zoological Survey of India, Calcutta, for providing facilities, and to Dr R. V. Melville Secretary, International Commission on Zoological Nomenclature, London, for his kind comments.

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25. CORRECT NAME OF THE RED-BASE JEZEBEL BUTTERFLY (LEPIDOPTERA: PIERIDAE)

The Red-base Jezebel butterfly is presently known as *Delias aglaia* (Linn.) and named as such in the well-known works of Evans (1932), Talbot (1939) and Wynter-Blyth (1957). I too noted it as *D. aglaia* while recording it for the first time from Indian mainland (Varshney & Nandi 1973). Unfortunately, the name *aglaid* has turned out to be an incorrect one and even invalid in this case.

A perusal of the original work SYSTEMA NATURAE, 10th ed. by Linnaeus (1758) showed that this butterfly was named as *"Papilio agalaja"* as Sl. No. 44 on page 465. Hence *"aglaja"* is incorrect (spelling), which incidentally Corbet & Pendlebury (1956) corrected.

Linnaeus however, in the same work has named another nymphalid butterfly also as *"Papilio aglaja"* at Sl. No. 140 on page 481. Thus, although strange, Linnaeus the father of Zoological Nomencalture, himself has committed primary homonymy! He has definitely considered these two species separate, while giving their different characters and placing the first in 'Papilio, Eques' Group, and the second in 'Papilio, Nymphalis' Group. At present the first Group is recognized as Family Pieridae and the second Group as Family Nymphalidae.

There is no such thing as a rule of 'page priority' in Zoological Nomenclature. The choice between two names published simultaneously is made, not according to their relative positions in the work, but by the first reviser, since the whole of one volume is considered published at the same time. In this case Linnaeus himself acted as the first reviser. In, the 12th edition of Systema Naturae (Linnaeus 1767) he has retained *"aglaja"* name for the nymphalid species, and replaced it with *"pasithoe"* for the pierid species.

The International Commission of Zoological Nomenclature have approved these changes, *vide* their Opinion No. 974, in 1971. Hence, pierid Red-base Jezebel butterfly should now be called as *Delias pasithoe* (Linn.).

In my revised nomenclature lists for Wynter-Blyth's book (Varshney 1980), an addition should be made in Table 5 as follows: "Sl. No. 1a; page 418; For *Delias aglaia* (Linn.), read *Delias pasithoe* (Linn.)".

ACKNOWLEDGEMENTS

I thank Dr. R. V. Melville, Secretary, International Commission on Zoological Nomenclature, London, for comments, and the Director, Zoological Survey of India, Calcutta for providing facilities.

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———— (1767): Systema Naturae. 12th ed., *1*(2): 533-1068.

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WYNTER-BLYTH, M. A. (1957) : Butterflies of the Indian region. Bombay Natural History Society, Bombay.

26. *CASSIA SIAMEA* LAMK.—A NEW HOST PLANT FOR THE CASTOR SLUG CATERPILLAR, *PARASA LEPIDA* (COCHLIDIDAE: LEPIDOPTERA)

Vasanthraj David and Kumarswami (1978) noted *Parasa lepida* as a polyphagous pest feeding on castor, coconut, pomegranate, mango, palmyrah, citrus and wood apple. During the months of August-September 1982 the larvae of this pest were found attacking the leaves of *Cassia siamea* a very common avenue tree. The early instar caterpillars scraped the chlorophyll content resulting in skeletonization of the leaves whereas the later instars fed on the leaves acting as a severe defoliator. The larvae fed both from the centre as well as from the margins. However, the majority of the larvae fed from the margins. The number of larvae per leaflet varied from 2 to 3. A few larvae were collected from the trees and reared in rearing cage by providing the leaves as food material. All the larvae completed their life cycle without any deformity. The full grown larvae pupated in a hemispherical, oval, dark brown cocoon which was surrounded by loosely wooven-silk webbing. Under field conditions pupation was observed on the branch or bark of the tree. *Parasa lepida* could be a serious pest on *Cassia siamea.*

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27. ADDITIONS TO THE TERMITE FAUNA OF THE THAR DESERT

The Great Indian Desert, also known as the Thar Desert, comprises a huge area of *c.* 44,600 sq. km in Western India and Pakistan. It forms the eastern extremity of the Great Palaearctic Desert which extends from North Africa, *via* Palestine, Arabia and Iran, to northwestern India. The major portion of the Indian arid region of Thar is contained in Rajasthan (62%), followed by Gujarat (20%), Punjab (5%) and Haryana (4%). Termites from the

Rajasthan portion of the Thar Desert were studied in considerable detail by a number of workers, as reviewed by Roonwal (1982). As many as 27 species have been recorded from this region (Roonwal 1976). But there is no published information available on the Gujarat, Punjab and Haryana portions of the Thar Desert.

Termite fauna of Gujarat State were worked out comprehensively (Thakur 1982) and 46 species were recorded. Out of these, as many as 27 species have been recorded from the arid and semi-arid areas of Gujarat, of which 11 are additions to the termite fauna of Thar Desert. This considerable increase in the termite fauna of this region has brought out the fact that even an arid area like the Great Indian Desert can sustain a great variety of termites, which shows the great resistance of termites to arid climates.

TERMITES HITHERTO UNRECORDED IN GUJARAT PORTION OF THE THAR DESERT

Family TERMITIDAE
Subfamily TERMITINAE

Eremotermes fletcheri Holmgren and Holmgren
Microcerotermes cameroni Snyder
Microcerotermes heimi Wasmann

Subfamily MACROTERMITINAE

Odontotermes assmuthi Holmgren
Odontotermes bellahunisensis Holmgren & Holmgren
Odontotermes girnarensis Thakur
Odontotermes lokanandi Chatterjee & Thakur
Odontotermes paralatiguloides Thakur
Odontotermes redemanni (Wasmann)
Odontotermes sasangirensis Thakur
Odontotermes wallonensis (Wasmann)

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28. FURTHER RECORDS OF OCCURRENCE AND INCIDENCE OF DAMAGE BY TERMITES OF THE GENUS *CRYPTOTERMES* BANKS IN INDIA (ISOPTERA: KALOTERMITIDAE)

INTRODUCTION

The genus *Cryptotermes* includes one of the most economically important groups of drywood termites which are popularly known as *"powder post termites"*. These are essentially coastal termites, except for records of some species further inland in native habitats (Emer-

son 1952, Chhotani 1963). The genus is generally tropicopolitan in distribution, approximately between 33° North latitude to 35° South latitude with the exception of a few species which occur in the warmer temperate regions, as far north as California and Washington D. C. in United States and England in Europe (Chhotani 1970). These are probably cases of accidental introductions. Within their range of distribution, these termites attack dead and dry portions of living trees in nature (native species) and woodworks in buildings, household furniture and other wooden structures (introduced species). The genus is represented by six species in the Indian region. Of these, *C. bengalensis, C. karachiensis* and *C. roonwali* are native species, while the remaining three, *C. domesticus, C. dudleyi* and *C. havilandi*, are introduced species, occurring in the Andaman and Nicobar islands (*C. havilandi*) and along the coastal regions of the Indian subcontinent (*C. domesticus* and *C. dudleyi*). This paper gives an account of further records of occurrence and incidence of damage by the above two introduced species in India.

Cryptotermes domesticus (Haviland)

Gay (1970) opines that the centre of origin of this species is probably the coastal regions of associated islands of South-East Asia. The only known record of its occurrence in exclusively wild habitat is from Botal Tabago Islands off the coast of Formosa (Hozawa 1915, Gay 1970), from where it appears to have dispersed to other localities through introduction and is now very widely distributed in Neotropical, Oriental and Papuan regions. In the Oriental region, it has been recorded from Andales (Sumatra), Taiwan, India, Japan, Java, Kalimantan (Borneo), Singapore, Sri Lanka, Thailand and Vietnam (Chhotani 1970, Sen-Sarma *et al.* 1975, Thakur 1980). Recently during the course of a survey in Kerala, the species was recorded as common at Kovalam beach (*c.* 20 km south from Trivandrum) and from a wooden pole at Kesavadasapuram (*c.* 10 km from Trivandrum).

TABLE 1

BODY MEASUREMENTS (IN MM) OF FIVE IMAGO OF *Cryptotermes domesticus* (HAVILAND) FROM KOVALAM BEACH, TRIVANDRUM

Sl. No.	Body parts	Range	Mean
	Caste – Imago		
1.	Total body-length with wings	c. 8.50-9.20	9.00
2.	Total body-length without wings	c. 5.40-6.30	5.80
3.	Head - length to tip of labrum	1.20-1.30	1.26
4.	Head - length to base of mandibles	0.85-1.00	0.93
5.	Maximum width of head (with eyes)	0.85-1.00	0.95
6.	Maximum height of head	0.60-0.65	0.63
7.	Maximum diameter of eye (with ocular selerites)	0.30-0.35	0.33
8.	Maximum diameter of lateral ocellus	0.08-0.13	0.10
9.	Minimum diameter of lateral ocellus	0.05-0.09	0.07
10.	Minimum ocellus - antennal distance	0.15-0.20	0.18
11.	Maximum length of pronotum	0.55-0.60	0.58
12.	Maximum width of pronotum	0.95-1.05	1.03

This species appears to have established itself in Singapore and Sarawak during the fag end of the nineteenth century and where it is now confined primarily to buildings, dry, seasoned timber, furniture and other fibrous products. In Vietnam, it has been reported

to cause considerable damage to wooden furniture and constructional timber (Gay 1967). In India, it was recorded earlier from wooden boat model of *Mangifera indica,* fence posts and timber godowns. It has now been collected from the base of dead blown down trees of coconut (*Cocos nucifera*), timber of old abandoned boats and a pole of a varandah in a house.

Individual colonies of *Cryptotermes domesticus* are usually small, not exceeding possibly 250-350 individuals. However, one of the colonies excavated at Kovalam was quite large and contained more than a thousand individuals. It had eaten away a large section of the interior of the infested materials, leaving only the outer rind. Faecal pellets accumulated in the chambers and the galleries had been pushed out through the exit holes at intervals. The faecal pellets piled up at the base in small heaps were conspicuous evidence of infestation. The shape of faecal pellets is cylindrical with rounded bulged out lateral faces. The surface is pentagonal, with five pit like depression and size varies from, 0.7-0.8 mm length; 0.4-0.5 mm width. The colour is dirty brown.

The swarming period varies with locality and occurs during the greater part of the year from April to November. From Kesavadasapuram, the alates were collected in May, emerging from a pole at ground level, while at Kovalam beach, fully matured adults were collected along with soldiers and pseudoworkers in the last week of November.

Cryptotermes dudleyi Banks

Cryptotermes dudleyi is a very widely distributed species in Australian, Ethiopian, Neotropical, Oriental and Papuan regions. However, clear evidence of its centre of origin and subsequent dispersion remains obscure. In the Oriental region, it has been recorded from East Andalas (Sumatra), Bangladesh, Java, India, South-East Kalimantan (Borneo), Malaya, the Philippines and Sri Lanka. From India, it has been reported from the Andaman Islands, union territory of Daman and Goa, Kerala (Cannanore), Orissa and West Bengal. Recently, it has been collected from Aryad village, about five km north of Alleppey town

Table 2

Body measurements (in mm) of soldiers of two species of *Cryptotermes* banks

Sl. No.	Body parts		*C. domesticus* (Haviland) Range		*C. dudleyi* Banks Mean
	I-General		(5-*examples*)		(1-*example*)
1.	Total body-length	..	*c.* 5.95-6.40	6.23	5.30
	II-Head				
2.	Head-length with mandibles	..	1.85-1.90	1.88	2.20
3.	Head-length to lateral base of mandibles	..	1.28-1.40	1.35	1.55
4.	Maximum width of head	..	1.30-1.40	1.37	1.30
5.	Maximum height of head	..	0.98-1.08	1.03	1.03
6.	Maximum length of pronotum	..	0.80-0.95	0.87	0.80
7.	Maximum width of pronotum	..	1.28-1.35	1.33	1.18

(*c.* 9°30′ N., 76°23′ E.) on a piece of land, separating Arabian sea and Vembanad backwater lake. It is about eight kilometres from the sea coast. This is a new distribution record.

In India, it is also an introduced species and is restricted to coastal regions, where it is a serious pest, damaging and destroying all types of wooden structures in buildings. At Aryad, it was recorded from roof rafters of an old house. The locality is densely populated and thatched huts with wooden roofs are very common. More than 50% rafters were found attacked, being completely riddled with chambers and galleries. The chambers are interconnected by an irregular net work of galleries. The chambers were found packed with faecal pellets. The faecal pellets are somewhat oblong in shape, slightly tapering to one side. The colour is usually transparent brown to opaquish grey. However, the colour varies according to texture of the host timber. The size of pellets varies from, 0.6-0.8 mm long; 0.3-0.5 mm wide. The smaller pellets are either smooth or with faint depression, whereas the larger pellets are similar to that those of *C. domesticus.*

Remarks

Though the measurements of alates of *C. domesticus* from Kovalam beach, Trivandrum, come within the range (as given by Chhotani 1970), the soldiers are distinctly larger in size, as is evident from the measurements given in Table No. 2.

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29. A SPIDER AS PREDATOR OF *LAMPIDES BOETICUS* (LINNAEUS) (LEPIDOPTERA: LYCAENIDAE) FROM PUNJAB, INDIA

Pea blue butterfly, *Lampides boeticus* (Linnaeus) a polyphagous pest primarily of leguminous crops has been reported infesting 42 host plants (Singh 1982). A wasp, *Eumenes gracilis* Rauss as predator, *Microbracon greeni* Ashm. as larval parasite, *Trichogramma minutum, Trichogramma dendrolini, Trichogrammatoidea guamensis* as egg parasites have already been recorded as natural enemies of this butterfly (Alfieri 1916, Sen 1938, Sweez 1906, Nagarkatti and Nagaraja 1975).

The yellow nymphs of two spider species namely *Thomisus shivajiensis* Tikader (Thomisidae) and *Clubiona abboti* Koch (Clubionidae) were recorded feeding on the adults of *Lampides boeticus* in the pigeon pea fields around Ludhiana (Punjab). In the laboratory the butterflies were trapped in spider webs and killed immediately by sucking their internal body contents. The spiders never fed on the dead butterflies. It was observed that a spider took 49.60 ± 6.74 minutes to devour an adult.

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We are grateful to the Prof.-cum-Head, Department of Entomology for facilities and Dr. G. L. Sadana, Assistant Professor, Department of Zoology, Punjab Agricultural University, Ludhiana for the identification of the spider species.

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30. SOME OBSERVATIONS ON THE BIOLOGY OF PLANORBID SNAIL *HELICORBIS COENOSUS* (BENSON) IN PUNJAB

(*With three text-figures*)

Helicorbis coenosus (Syn. *Segmentina coenosus*) is reported by different authors (Buckley 1939, Dutt and Srivastava 1966) to act as intermediate host of two important trematode parasites of man and pig in India, namely *Gastrodiscoides hominis* (Lewis & Mc-

Connel 1876) and *Fasciolopisis buski* (Lankester, 1857). This snail has been recorded in four districts, namely Amritsar, Ludhiana, Kapurthala and Ropar in a year round survey of the Punjab State. No account on the various aspects on the life history of this important snail of zoonotic importance was found in the literature, except a very preliminary work done by Tripathi *et al.* (1973). This paper records our observations about its life history under laboratory conditions.

TABLE 1

LABORATORY TEMPERATURE (°C)

Month	Mean air temperature		Mean water temperature	
	Daily range	Monthly	Daily range	Monthly
January	18.5-19.7	19.0	14.4-15.7	15.5
February	19.2-21.8	18.67	13.9-17.5	15.7
March	20.6-23.9	22.3	15.4-19.8	17.6
April	27.4-30.6	29.0	22.4-27.6	25.0
May	29.1-35.0	32.0	24.1-33.5	28.8
June	30.2-36.1	33.2	26.4-33.1	29.8
July	31.1-34.5	32.8	29.2-32.6	30.9
August	28.6-32.5	32.2	27.8-31.0	31.0
September	28.0-31.8	29.9	26.1-32.0	29.0
October	26.7-29.7	28.2	24.9-28.9	26.9
November	22.2-27.0	24.6	21.6-25.0	23.3
December	22.5-26.8	24.6	18.1-22.3	20.2

MATERIALS AND METHODS

Adult specimens of the snails were collected from a semi-dried pond at Katli village in Ropar district. Snails were reared in beakers of 500 ml. capacity, and fed with spinach (*Spinacia oleracea*) and *Trienthema govinda* (Hindi, *Santhi;* Punjabi, *Itsit*). Some decaying leaves and grass stems collected along with the snails were also kept in the beakers. A few plants of an aquatic weed *Hydrilla verticillata* were planted in the aquaria to serve as aerators and egg traps. The water of aquaria was changed once a week. Egg clutches laid by adult snails on the weed were collected and kept in Petri-dishes for development. Freshly hatched snails were transferred to different aquaria each containing one to three snails. In summer hatch group (March to May) and 18 in similar combinations in winter hatch group (Nov. and Dec.). Observations were recorded daily and any snail found dead was removed. Monthly size of the egg clutches, eggs and newly hatched snails was measured by eye piece micrometer and growing snails by slide calipers.

Temperature of the laboratory was regulated by using room heaters during winter and air conditioner during summer and temperature was recorded daily. Similarly water temperature of the glass aquaria was also recorded.

OBSERVATIONS

Laboratory air and water temperature is given in the table 1. From the table it can be seen that the daily mean air temperature varied from 19.2-36.1°C and monthly mean from 18.7 to 33.2°C. During winter months (Nov. and December) the mean monthly air temperature was 24.6°C. Mean water temperature for the month of November was 23.3 and for December it was 20.2°C.

During summer months (March to May) the mean air temperature varied from 22.3 to 30.0°C and mean water temperature varied from 17.6 to 28.8°C (Fig. 3).

Egg clutches. Leaves of the aquatic weed (*Hydrilla verticillata*) were found to be very congenial for egg laying as 99% of the egg clutches were found on them possibly as these were the only leaves available to the snails. Egg clutches were found firmly attached on the surfaces of dead leaves and stems. They were

TABLE 2

GROWTH RATE OF *Helicorbis coenosus* IN LABORATORY CULTURES

Age/ (Months)	Summer hatch Shell size (mm) Minimum L	B	Maximum L	B	Average L	B	Age/No. of snails	Winter hatch Shell size (mm) Minimum L	B	Maximum L	B	Average L	B
(A) Snail reared in groups													
1(10)	1.5	1.25	3.5	3.0	2.28	2.17	1(10)	—	—	—	—	—	—
2(10)	3.5	3.0	5.0	4.5	4.58	3.75	2(10)	1.5	1.0	4.0	3.0	2.85	2.25
3(10)	5.0	4.0	6.0	5.0	5.33	4.45	3(10)	2.75	2.0	5.0	4.0	3.38	2.55
4(10)	4.5	4.0	7.0	6.5	5.68	4.9	4(10)	2.75	2.0	5.25	4.0	3.98	3.0
5(10)	5.0	4.0	7.0	6.5	5.83	5.05	5(10)	2.75	2.0	6.5	6.0	4.78	4.1
6(10)	5.0	4.0	8.0	7.0	6.23	5.2	6(10)	3.0	2.0	6.5	6.0	5.43	4.75
(B) Snails reared singly													
1 (6)	2.0	1.5	3.5	3.0	2.70	2.25	1 (6)	—	—	—	—	—	—
2 (6)	3.0	2.5	6.0	4.0	4.50	3.58	2 (6)	1.5	1.0	3.5	3.0	2.29	1.75
3 (6)	3.5	2.5	7.0	6.0	5.37	4.33	3 (6)	2.75	2.0	4.5	4.0	3.29	2.41
4 (6)	4.0	3.5	7.0	6.0	6.41	5.16	4 (6)	3.0	2.0	6.0	5.5	4.37	3.50
5 (5)	4.5	3.5	7.25	6.0	6.10	5.10	5 (6)	3.75	3.0	7.0	6.5	5.45	4.66
6 (3)	5.0	3.5	7.5	6.25	6.66	5.25	6 (4)	5.5	4.0	7.0	6.5	6.37	5.37

Note: Figures in parentheses indicate number of snails.

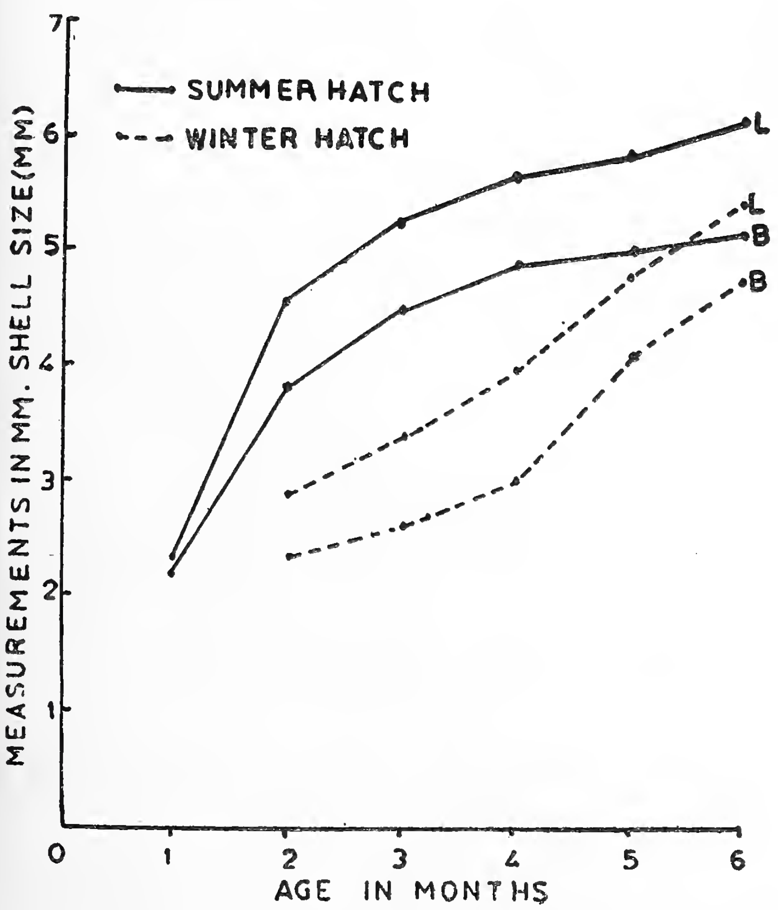

Fig. 1. Mean growth rate of Laboratory bred *Helicorbis coenosus*. (10) reared in groups.

suboval, round or elliptical. These clutches had an outer membrane enclosing a gelatinous material in which eggs varying from 1 to 22 were arranged in a characteristic fashion. Shape of the egg was roughly oval.

Thirty egg clutches brought in the month of November (Mean temp. 24.6°C) from the field biotope measured 1.0 × 0.75 to 4.75 × 3.0 (mean 2.70 × 1.72) mm). A number of eggs in these clutches ranged from 1-33. These eggs failed to hatch in the laboratory although the development in them was normal.

Growth. Data on the growth in shell size of the snail reared in groups of two or three both in summer and winter groups are presented graphically in figure 1, and single reared snail in figure 2. Monthly record of their development for both summer and winter hatch group is given in table 2. During summer hatch young snails under laboratory cultures attained the average size of 2.28 mm in

TABLE 3

NUMBER OF EGGS CLUTCHES & EGGS LAID BY *H. coenosus* IN LABORATORY CULTURES DURING MONTHS FOLLOWING FIRST OVIPOSITION AND MAXIMUM SIZE(S) REACHED BY SNAILS IN FULL LIFE SPAN.

No. of snails	No. of egg masses			Number of egg			Size of snails at the time of death		Life span
Total	Total	Range	Mean	Total	Range	Mean	Range	Mean	(Months)
(A) SUMMER HATCH 65	970	0-134	14.92	6125	11-929	94.23	2.5 x 2.0 to 9.0 x 7.75	4.7 x 3.9	13
(B) WINTER HATCH 18	277	0-82	15.38	1692	0-591	94.0	3.0 x 2.0 to 7.25 x 6.0	5.5 x 4.7	10

length and 2.17 mm in breadth during the first month of their life. Average maximum length reached during the sixth month period for which the observations were recorded was 6.23 × 5.2 mm.

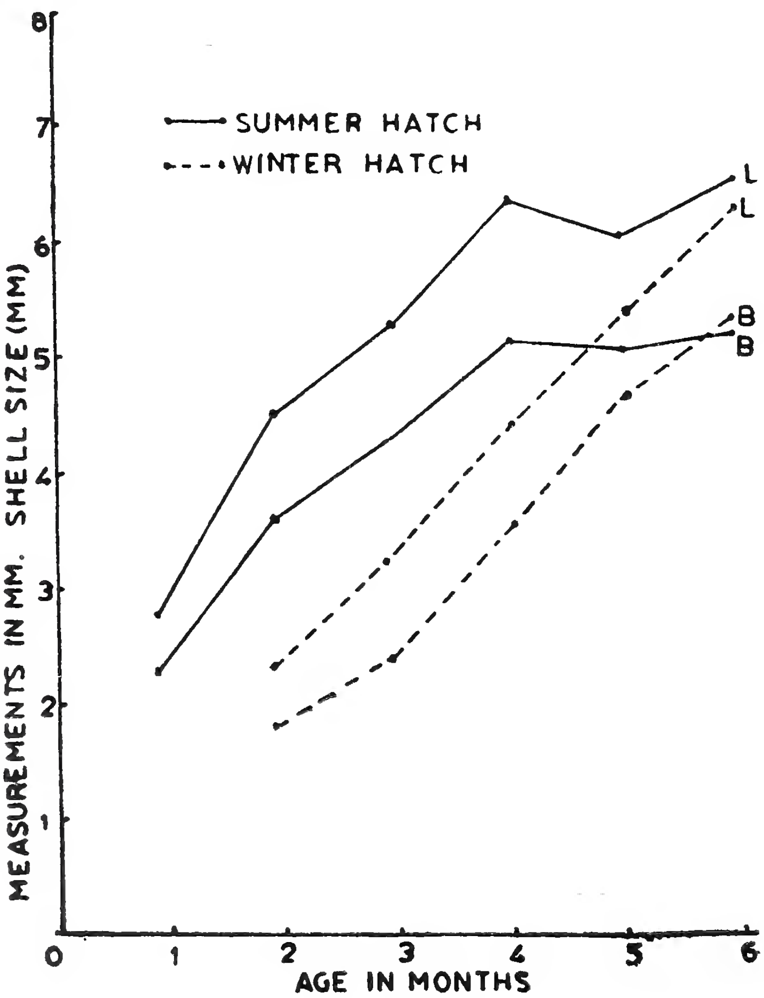

Fig. 2. Mean growth rate of Laboratory bred *Helicorbis coenosus*. (6) reared singly.

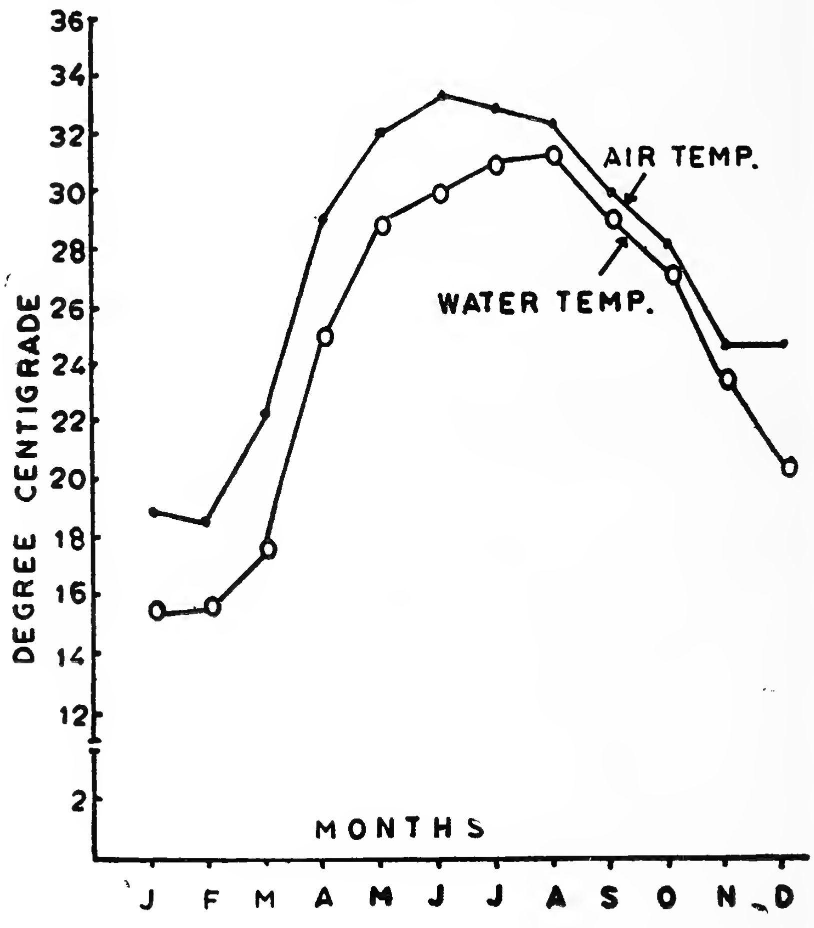

Fig. 3. Mean Room Temperature.

Singly reared snails attained the size of 6.66 x 5.25 mm during the same period.

In winter hatch snails the average size attained by the snails in six months was 5.43 × 4.75 mm whereas singly reared snails attain-

ed the size of 6.37×5.37 mm. during the same period.

Development in 65 snails maintained in 1, 2 and 3 snail groups in separate glass aquaria during summer months was recorded. Observations were recorded till they died. Eggs laid by the snails varied in size from $0.35\text{-}0.52 \times 5.5\text{-}0.85$ mm. No. of eggs in one clutch ranged from 1 to 33. First cleavage of embryo was noticed within 8 hours after deposition and vigorous movement of all embryo was observed after 12-15 hours. Hatching of eggs took place in 3-14 days when the daily temperature range was 29.1° to 35.0°C. Embryo was surrounded by yolk material which was enclosed in their vitelline membrane.

In winter hatch groups when the water temperature was below 23°C eggs ceased to hatch although the development of larvae within the egg clutches was normal and movement of juveniles within the eggs was seen.

Maturity & Fecundity. Snails became mature at the age of 26 to 52 days during summer months when the shell size ranged from 1.5×1.25 to 4.5×4.0 mm only 6.3% of the snails laid eggs when kept singly and the number of eggs laid in life time ranged from 0 to 216. Eight per cent of snails when kept in pairs or more in a laboratory culture laid eggs and the number in life time ranged from 0 to 929. Age of egg laying of the snail varied from 26 to 145 days.

In winter hatch groups temperature below 23°C the age of maturity was delayed. It reached upto 137 days although the size attained by such snails was 5.5×5.0 mm. Egg to egg cycle in this snail was completed in 4-20 weeks.

Longevity. The maximum longevity recorded was 13 months and the size reached by this snail was 8.0×7.5 mm. However, the maximum size of one snail recorded in laboratory was 9.0×7.5 mm in seven months in singly kept group.

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31. "*CAESALPINIA HYMENOCARPA* (PRAIN) HATTINK, COMB. NOV. — A SUPERFLUOUS NAME"— A CORRECTION

In accordance with article 34.1.d International Code of Botanical Nomenclature (1978) Utrecht, the proposal in the article "*Caesalpinia hymenocarpa* (Prain) Hattink Comb. Nov. — A superfluous name, J. Bombay nat. Hist. Soc. 1982, 79(3): 713" is incorrect. As such, the combination *Caesalpinia hymenocarpa* (Prain) Hattink, stands valid.

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32. FAMILY ALISMATACEAE IN THE KASHMIR HIMALAYAS

(*With two plates*)

Alismataceae, an interesting family with about 13 genera and about 60 species, is cosmopolitan in distribution. It is represented by 2 genera with about 6 species in our area.

Six species included in 2 groups were palynologically investigated. The species have no distinction in the number of apertures and in their structure, but differ markedly in the exine stratification. The grains are polyporate, polyhedral, cribellate; exine subechinate, spines sharp, conical and the meshes of the reticulum are polygonal in *Sagittaria,* where as in *Alisma* the pollen grains are 5-7 porate; exine reticulations polygonal fine, without spines. The specific delimitations in both the genera is difficult, because of the presence of the same type of pollen grains, but there is slight variation in shape, size, meshes of the reticulum and in the size of the spines in *Sagittaria* species.

Key to the genera

Flowers bisexual, stamens 6; carpels borne in one series; achenes verticillate; endosperm helobial.... .... *Alisma*

Flowers unisexual; stamens more than 6, borne in more than one series; achenes capitate; endosperm nuclear type .... *Sagittaria*

Alisma L. Sp. Pl. 342 (1753)

A genus with about 10 species, widely distributed in the temperate and tropical regions of the world. It is represented by 3 species in this area.

Key to species

1. Style recurved shorter than ovaries; anthers suborbicular .... *A. gramineum*
1. Style erect, longer than the ovaries; anthers elliptic oblong.
   2. Leaves broadly linear lanceolate, gradually narrowed at the base into a petiole; petals acute .... *A. lanceolatum*
   2. Leaves broadly lanceolate, ovate, rounded or slightly cordate at the base; petals obtuse .... *A. plantago-aquatica*

Alisma lanceolatum With. Arrang. Brit. Pl. ed. 3.2: 362 (1796); Gafoor, Fl. W. Pak. 68; 4 (1974).

A. plantago-aquatica L. var. *lanceolatum* (With) Koch, syn. Fl. Germ. 669 (1837).

Radical leaves lanceolate, long petioled, smooth, sheathing at the base, Scapes triqutrous; petals in two series; outer ones ovate,

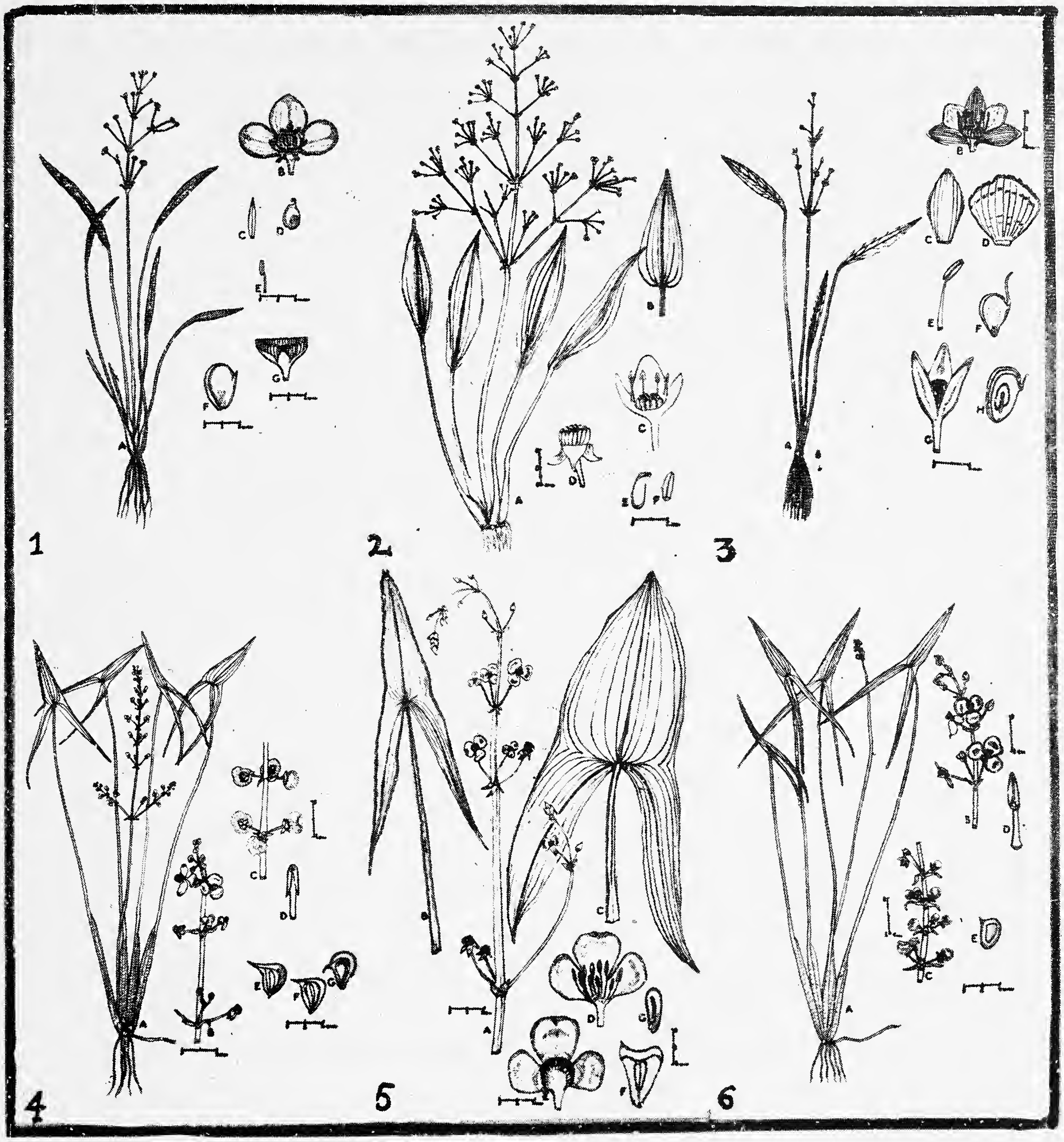
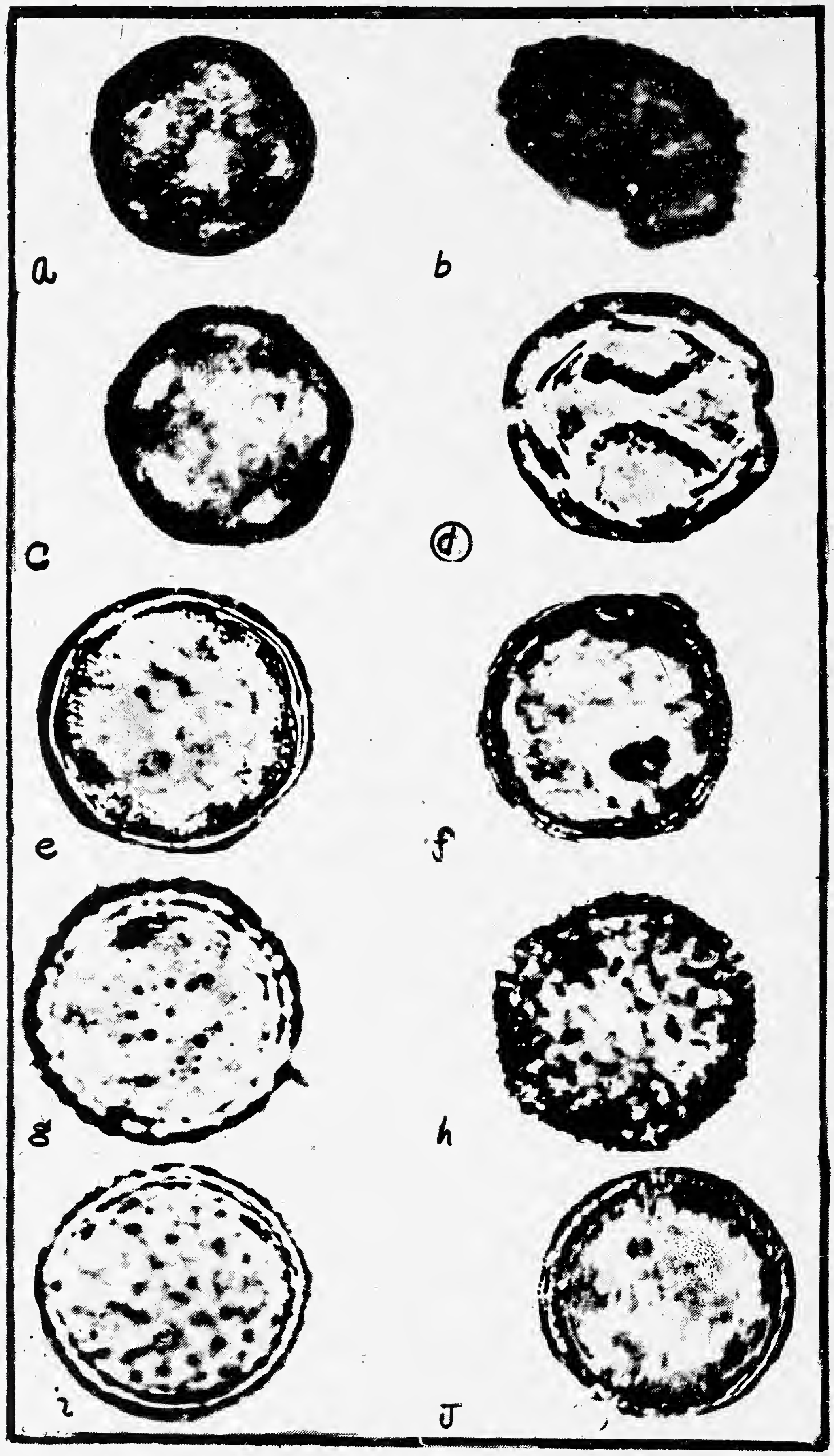


Fig. 1. *Alisma gramineum* Gmel.: A. Habit; B. Flower; C. Bract; D. Ovary; E. Stamen; F. Achene; G. Fruit.
Fig. 2. *Alisma plantago-aquatica* L.: A. Habit; B. Leaf; C. Flower; D. Fruit; E. & F. Achene.
Fig. 3. *Alisma laceolatum* With.: A. Habit; B. Flower, l.s.; C. Outer perianth; D. Inner perianth; E. Stamen; F. Ovary; G. Fruit; H. Achene.
Fig. 4. *Sagittaria latifolia* Willd.: A. Habit; B. Flowering branch; C. Fruiting branch; D. Stamen; E. & G. Achene (variations).
Fig. 5. *Sagittaria sagittifolia* L.: A. Habit upper portion; B. & C. Leaf variations; D. Staminate flower, l.s.; E. Pistillate flower; F. Achene; G. Embryo.
Fig. 6. *Sagittaria greggi* Smith.: A. Habit; B. Flower branch; C. Fruiting branch; D. Stamen; E. Achene.



Figs. a, b: *Alisma plantago-aquatica.*
c, d, e: *Alisma lanceolatum.*
f: *A. gramineum.*
g, h: *Sagittaria sagittifolia.*
i: *S. greggi.*
j: *S. latifolia.*

inner rhomboid, white or rosy pink; carpels 17-21, in a ring on the flat receptacle, style straight, lateral; stigma linear, long. Achenes obovate with 1-2 furrows at the back, 2-3 mm dia., pale brown. Seeds oblong 1.5 mm dia.

Common in shallow water, on wet mud, in the marshes, on the sides of streams and floating islands, also in the running waters of the irrigating channels. Boulevard AMK 744; Shalimar AMK 870; Suderbal AMK 3389.

Alisma plantago-aquatica L. Sp. Pl. 342 (1753); Hook. f. Fl. Brit. Ind. 5: 559 (1893); Gafoor, l.c. 4.

A robust scapigerous herb, which can be distinguished in the field by the radical leaves tufted, broadly linear-ovate, lanceolate, cordate; outer perianth slightly fused at the base; ovate or oblong; pale pink; ovary globular. Achenes oblong, obovoid, 2-3 mm dia., 1-2 grooved on the back, pale brown.

Usually in shallow waters, marshes, streams and in the ponds; near bogs; Anchar lake AMK 3100; Shalimar AMK 3149.

Distribution. India, Burma, Russia, Europe and Tropical Africa.

Alisma gramineum Lej, Fl. Spain I: 175 (1811): Gafoor, l.c. 6. *Alisma plantago-aquatica* L. var. *decumbens* Boiss. Fl. Or. 5:9 (1882).

In the field it can be readily identified in having thick rootstocks, variable leaves; linear lanceolate or elliptic oblong. Flowers in scapose verticillate panicles; outer ones ovate; inner ovate rhombic caducous, white or purplish white; ovary subovate; stigma punctate; style recurved. Achenes raniform or orbicular, 3 ridged on the back, broadest near the apex.

On the mud in shallow waters; in the quiet or swift moving streams, near boggy or marshy places. Verinag AMK 3400; Shalimar AMK 3806; Hokhar Sar AMK 3101.

Superficially the taxon resembles *A. lanceolatum* but can be differentiated from it in having anthers suborbicular; style recurved, shorter than the ovaries.

SAGITTARIA L. Sp. Pl. 993 (1753)

A cosmopolitan genus with about 40 species, represented by 3 species in this area. It is a highly plastic genus exhibiting much variation in the leaves and in the flowers depending on the nature of the habitat in which it grows. It is observed that all these varients do not deserve taxonomic status. However, on the basis of the characters given in the key we have been able to recognise 3 species in this area.

KEY TO SPECIES

1. Achenes triangularly obovate, with a conspicous dorsal wing; long beaked.
   2. Beak horizontal, 1-2 mm long .... *S. latifolia*
   2. Beak laterally bent, more than 2 mm long .... *S. sagittifolia*
1. Achenes minute or inconspicuously beaked, equally winged both sides .... *S. greggi*

Sagittaria latifolia Willd. Su. Pl. 4: 409 (1806); *S. virabilis* Engelm in A. Gray Man. 461 (1848); *S. esculentus* Howell. Fl. NW. Am. 679 (1903)

In the field the species can be readily identified by the thick rootstocks. Leaves much variable; scapes equalling leaves, angular above; pistillate flowers in lower whorls. Achenes obovate, 3-3.5 × 3 mm with broad marginal wings and no facial keel; beak slightly incurved, horizontal or nearly so.

Common near damp areas, on the margins of the lakes. Leper Hospital (Nagin lake) AMK 3806, 3807; Shalimar AMK 3872; Brean (Nishat) AMK 3734.

Distribution. Europe, America, Asia, Himalayas.

The tubers are eaten in India under the name Wappato. In China it is cultivated and frequently eaten. In Kashmir the tubers are sold in the market under the name *Keuw*, they are eaten raw or after boiling. But now they are not at all available, may be because of the near extinction of the habitat in which it grows.

Sagittaria sagittifolia L. Sp. Pl. 993 (1753): Hook. f. Fl. Brit. Ind. 6 : 561 (1893); *S. trifoliata* L. Sp. Pl. 993 (1753): Yuzechuk in Kamarov. Fl. URSS 7: 288 (1934): Fafoor, l.c. 8.

Ohwi (1905) and Gafoor (1974) considered *S. sagittifolia* L. as *S. trifoliata* L. and Gafoor (l.c.) thinks that north-west Himalayan specimens differ from the European and N. Asian *S. sagittifolia* in having petals white without the basal purple spot, yellow rather than purple anthers, reflexed rather than spreading sepals and very acute rather than blunt tips of the basal lobes of the leaf, which are often longer than the blade. He has studied all these character in a specimen collected by Stewart from Kashmir and preserved in the Herbarium, University of Rawalpindi (Pakistan). However, our population has white petals with yellow spots at the base, sepals spreading but reflexed at the fruiting stage and the sepals usually obtuse. Therefore the characters are those of *S. sagittifolia* L. and the name has been retained.

In shallow waters of ditches, ponds and swamps, especially near road side ditches, rare on the sides of the lakes. Shalimar AMK 3151; Gagribal Park AMK 2094; Malgam Rakh AMK 3324; Ugjan (Anantnag) AMK 3735; Verinag AMK 3809.

Distribution. India, China, Malaysia, Japan, Philippines.

The aerial parts are fed to cattle and the tubers are eaten raw.

Sagittaria greggi J. G. Smith, Rep. MO. Bot. Gard. 6 : 43 (1894); Abrams *et al.* Illus. Fl. Puci. States. 1 : 102 (1955).

The species is very rare and can be easily identified in having polymorphic, sagittate leaves, lateral lobes acuminate. Scapes erect with 6-9 whorls of unisexual (rarely perfect) flowers; bracts ovate or orbicular, reflexed; filaments dialated at the base; carpillodes present in the staminate flowers. Achenes obovate, 2-3 mm long, winged lateral ribs irregularly thickened, winged or tubercled, orbicular in outline, beak short erect or lateral.

Common in shallow ditches, marshy or boggy places, near slow running streams. Dialgam (Ugjan) AMK 3214; Verinag AMK 3871.

Distribution: Europe, Australia, Asia, Kashmir.

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REFERENCES

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HOOKER, J. D. (1893) : Flora British India 6: 561.

LINNAEUS, C. (1753): Species Plantarum Holmiae.

33. ADDITIONS TO THE FLORA OF BIHAR AND ORISSA—IV

The paper reports 14 new records of plants for Bihar and Orissa, collected by us from Bhubaneshwar and Ganjam district of Orissa. *Ophiorrhiza trichocarpos* Bl., hitherto restricted to Andaman and Nicobar Islands is reported from the main peninsula of India for the first time.

All the specimens are preserved in the herbarium of the Regional Research Laboratory, Bhubaneshwar.

Acalypha lanceolata Willd.

Gollabandh, occasional on sandy ground around coastal plantations, fl. 21.x.1978. *Saxena & Brahmam* 3350.

Distribution. Deccan Peninsula from Karnataka and Circars southwards; Sri Lanka, Burma, Java and Sumatra.

Ammannia octandra Linn. f.

Aska, occasional weed in fields, fl. & fr. 27.ii.1978. *Saxena & Brahmam* 3249.

Distribution. Deccan Peninsula; Sri Lanka, Burma, and Malaysia.

Cyperus alopecuroides Rottb.

Occasional along the margins of ponds — Sorada, fl. & fr. 16.ix.1977. *Saxena* 2891; Berhampur, fl. & fr. 22.ii.1978. *Saxena & Brahmam* 3201.

Distribution. Widely distributed in India; Bangladesh, Pakistan, Sri Lanka, Africa, Tropical Australia.

Eulalia quadrinervis (Hack.) O. Ktze.

Mahendragiri, 1000-1400 m., frequent in open grassy hill-slopes, fl. & fr. 25.x.1978 and 24.ix.1979. *Saxena & Brahmam* 3656, 3943.

Distribution. Subtropical Himalayas from Simla to Sikkim, Mishmi and Khasia Hills; Burma, China, Laos and Thailand.

Glycine wightiana (Wight & Arn.) Verdcourt

G. javanica auct. non Linn.

Serango, occasional in forest undergrowth, fr. 5.i.1978. *Brahmam* 3024.

Distribution. Plains of Western Peninsula; Sri Lanka, Java, Tropical Africa.

Jansenella griffithiana (C. Muell.) Bor

Mahendragiri, 1450 m., in open marshy grassland, fl. 25.x.1978. *Saxena & Brahmam* 3678; fl. & fr. 23.xi.1979. *Saxena & Brahmam* 3883.

Distribution. Khasia Hills, Assam, Western Ghats, Bailadilla (Madhya Pradesh), Karnataka, Tamil Nadu; Sri Lanka, Burma.

Lepidagathis cristata Willd.

Berhampur, in open dry places, fl. & fr. 8.i.1978. *Brahmam* 3123.

Distribution. East coast of India from Krishna river to Kanyakumari.

Neanotis quadrilocularis (Thw.) Lewis

Anotis quadrilocularis (Thw.) Hook. f.

Mahendragiri, 1000 m., in open grasslands under partial shade, fl. & fr. 27.x.1978. *Saxena & Brahmam* 3729.

Distribution. Karnataka, Travancore; Sri Lanka.

Ophiorrhiza trichocarpos Bl.

Mahendragiri, occasional in forest undergrowth, fl. & fr. 26.x.1979. *Saxena & Brahmam* Acc. No. 3773.

Distribution. Andaman and Nicobar; Bangladesh, Burma, Java, Malaysia.

Parthenium hysterophorus Linn.

Bhubaneswar, an introduced weed along roadsides and railway lines, fl. 20.xi.1977. *Brahmam* 2945.

Distribution. Introduced in India in 1956 and spread to many parts — Maharashtra, Karnataka, Madhya Pradesh, Delhi, Uttar Pradesh, Jammu and Kashmir, etc.; a native in tropical America from Florida to Texas, locally north to Massachusetts, Pennsylvania, Ohio,

Michigan, Illinois, Missouri and Kansas; also collected from West Indies and S. Africa.

Paspalum compactum Roth

Mahendragiri, 1400 m., common in open wet grasslands, fl. 25.x.1979. *Saxena & Brahmam* 3680.

Distribution. Mount Abu (Rajasthan), Khasi and Naga Hills, Nilgiris and other hills in the Southern and Western India.

Paspalum conjugatum Berg.

Mahendragiri, 1400 m., frequent in open marshy grassland, fl. & fr. 22.xi.1979. *Saxena* & Brahmam 3882.

Distribution. Kachar, Assam; Sri Lanka, Malaysia, Singapore and other tropical and subtropical regions of the world.

Plectranthus nilghericus Benth.

Mahendragiri, over 1300 m., in shady places, fl. 25.x.1978. *Saxena & Brahmam* 3611.

Distribution. Western Ghats, Anamalai Hills, Nilgiris.

Psychotria fulva Buch.-Ham. ex Hook. f.

Mahendragiri, 1000 m., in semi-evergreen forests, fl. & fr. 21.xi.1979. *Saxena & Brahmam* 3969.

Distribution. Assam and Khasia Hills upto 1200 m., Kachar, Manipur; Burma.

ACKNOWLEDGEMENTS

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34. THE GENUS *CURCUMA* L. (ZINGIBERACEAE) ON ANDAMAN AND NICOBAR ISLANDS

(*With a plate*)

The majority of the Zingiberaceae are very poorly known due to the fact that a clear understanding of the genera and species can be had only from live plants. Herbarium materials are hardly sufficient to know the nature and characters of the floral parts. In order to get a better understanding of these obscure species, they were collected, brought under cultivation and studied in live condition when in flower. As a result of these studies the genus *Curcuma* is revised here for these islands.

The genus *Curcuma* with about 45 species is confined to Indo-Malesian region. Apart from the classical world monograph of the genus by K. Schumann (1904), the genus has been revised for Malaya by R. E. Holttum (1950) and for Assam by A. S. Rao & D. M. Verma (1972). Further van Zijp (1915), van Zijp & Valeton (1917) and Valeton (1919) have published several notes and descriptions of Malaysian and Javan species. Apart from these few papers, very little work has been done on the taxonomy of this genus.

The characteristic features of the genus are the usually aromatic rhizomes, the broad adnate pouched bracts with a cincinnus of several

flowers in each pocket, the tuft of differently coloured coma of sterile bracts at the apex of the spike and the versatile anthers which are often spurred. Some of the species are cultivated for spices, medicinal uses and for food and have often run wild and established themselves in waste ground. Hence the natural distribution of these are obscure.

A review of literature so far published on the flora of Andaman and Nicobar Islands indicate that no species of *Curcuma* has been reported from these islands except the mention of *C. kurzii* by Hooker in Fl. Brit. Ind. 6: 216. 1890 under 'imperfectly known species' with a meagre description. This species is found to be synonymous to the Burmese species *C. petiolata* Roxb. which appears to be the only indigenous species of these islands, always seen in primary forests and never in waste ground. *C. longa,* the well known spice *'Turmeric'* is often cultivated near home-steads and fringes of cultivated fields and is very rarely seen in wild condition, *C. mangga* and *C. zedoaria* grow commonly in waste-ground near villages and roadsides and never in primary forest areas and are probably introduced exotics.

CURCUMA

CURCUMA L. Sp. Pl. 1: 2. 1753 et Gen. Pl. ed. 5.3. 1753; K. Schum. in Engler, Pflanzenr. 20: 99-115. 1904; van Zijp in Rec. Trav. Bot. Neerl. 12: 340-347. 1915; van Zijp & Valeton in Rec. Trav. Bot. Neerl. 14: 127-142. 1917; Valeton in Bull. Jard. Bot. Btzg. II, 27: 1-167. 1919; Holttum in Gard. Bull. Singapore 13: 65-72. 1950; A. S. Rao & D. M. Verma in Bull. Bot. Surv. India 14: 121-122. 1972.

Detailed generic descriptions are available in literature.

Distribution: Indo-malesian region and tropical Australia; about 35 species, 4 in Andaman & Nicobar Islands.

Key to the species

1a. Inflorescence central, arising through the middle of leafshoot; peduncle surrounded by sheaths of normal developed leaves.
- 2a. Cultivated plants of human habitations and waste grounds; rhizome bright orange yellow inside; petioles less than 1 cm long; floral bracts acute; coma bracts white or white streaked with green; flowers white; anthers spurred.................... 1. *C. longa*
- 2b. Wild plants of primary forest areas; rhizome pale yellow inside; petiole 8-15 cm long; floral bracts obtuse; coma bracts pink or pinkish orange; flowers creamy white; anthers not spurred.................... 3. *C. petiolata*

1b. Inflorescence lateral, separate from leaf shoots; peduncle not surrounded by sheaths of normal developed leaves.
- 3a. Rhizome citron yellow within; leaves uniformly green; bracteoles white; median band on lip not with red margins.................... 2. *C. mangga*
- 3b. Rhizome light yellow within; leaves with feather-shaped purplish flush on either side of midrib above throughout its length; bracteoles pinkish at apex; median yellow band on lip with red margins.................... 4. *C. zedoaria*

1. **Curcuma longa** L. Sp. Pl. 1: 2. 1753, *pro. max. parte;* Koenig in Retz. Obs. Bot. 3: 72. 1783; Baker in Hook. f. Fl. Brit. Ind. 6: 214. 1890; K. Schum. in Engler, Pflanzenr. 20: 108. 1904; Wealth of India 2: 402, t. 17. 1950; Burtt in Notes R. Bot. Gard. Edinb. 35: 212. 1977. [*Manjella kua* Rheede, Hort. Malab. 11: 21, t. 11. 1692]. *C. domestica* Valeton in Bull. Jard. Bot. Btzg. II, 27: 31. 1918; Ridl. Fl. Mal. Pen. 4: 254. 1924; Holtt. in Gard. Bull. Singapore 13: 68. 1950; Backer & Bakh. f. Fl. Java 3: 72. 1968.

Detailed descriptions are available in literature.

Flowering: July-September.

Distribution: Cultivated throughout tropical Asia.

Notes: For detailed discussion on typification and nomenclature see Burtt (l.c. 1977). No reference to this species is seen in any of the earlier literature on these islands and seems to be a recent introduction to these islands. This species is often cultivated in Andaman islands and Little Andaman island and sometimes in Nicobar Islands and is not seen in wild anywhere. Rhizomes called 'Turmeric' is used as spice in food preparations and also medicinally in various Ayurvedic preparations. A paste from the rhizomes is applied externally for sprains and wounds.

2. **Curcuma mangga** Val. & van Zijp. in Bull. Jard. Bot. Btzg. II, 27: 50, t. 6, f. 1. 1918. Ridl. Fl. Mal. Pen. 4: 254. 1924; Holtt. in Gard. Bull. Singapore 13: 70. 1950; Backer & Bakh. f. Fl. Java 3: 72. 1968.

Primary tubers ovoid, ± 5 cm long, ± 4 cm thick; rhizomes ± 3 cm thick with many close ± 1.5 cm thick branches projecting in all directions, pale dull yellow outside, pale citron yellow inside, tasting bitter; scale leaves subpersistent; roots many, descending and bearing ellipsoid tubers at ends. *Leaf-shoots* 80-100 cm high, bearing 3-5 leaves; sheaths 30-40 cm long; petioles ± 2 cm long; ligules rounded, ± 5 mm long; leaf-blade oblong-elliptic, acute at base, acute or ocuminate at apex, 30-50 cm long, 15-23 cm wide, uniformly glossy green above, pale and pubescent beneath. *Peduncle* 18-25 cm long, ± 1 cm thick (*in vivo*), covered with 3-5 rounded mucronate sheaths; spikes oblong, ± 15 cm long, ± 7 cm thick; floral bracts broadly oblong, blunt at apex, ± 4 cm long, connate for less than half-way, green with purple tinge at apex; coma bracts elliptic, acute, ± 7 cm long, almost free, pinkish purple.

Flowers 3-4 in each cincinnus inside each floral bract-pouch, 3-4 cm long; bracteoles elliptic, boat-shaped, prominently keeled and acute at apex, ± 3 cm long, ± 2 cm wide, white.

Calyx obtusely 3-dentate, ± 1 cm long, densely hairy at base.

Corolla-tube ± 2 cm long, cup-shaped towards upper half, tinged with yellow inside; lobes 3, oblong, acute, posterior lobe prominently boat-shaped, mucronate at apex, ± 1.5 cm long, ± 1 cm wide, white. *Staminodes* oblong, with concave median fold as seen from back; inner edges folded under the hood of the dorsal petal, obtuse at apex, ± 1.5 cm long, ± 0.8 cm broad, very pale yellow at upper half, white at lower half. *Lip* obscurely 3-lobed, ± 2.5 cm long, ± 1.8 cm wide, light yellow; midlobe emarginate at apex, yellow with a bright yellow median band. *Filament* constricted at top, ± 6 mm long, ± 3 mm broad, pale yellow; anther ± 4 mm long, white; spurs 2, narrow, slightly curved, ± 2 mm long, white. *Ovary* hairy; stylodes 3-6 mm long; style slender, ± 1.6 cm long; stigma bilobed. *Fruit* oblong, ± 2 cm long, hairy.

Flowering: June-August.

Specimens: S. ANDAMANS: Ferrargunj, collected in vegetative condition and flowered under cultivation on 5 June 1978, *Balakrishnan* 6747 (PBL).

Distribution: Java, Malaya and Andaman Islands.

Notes: An addition to Flora of India. Common in all waste grounds in open sunny places, roadsides, ditches, streamsides, etc. in South Andamans. This is not seen in other islands and is probably a recent introduction.

3. **Curcuma petiolata** Roxb. Fl. Ind. ed. 1, 1: 37. 1820; Hook. f. in Bot. Mag t. 5821. 1870; Baker in Hook. f. Fl. Brit. Ind. 6: 216. 1890; K. Schum. in Engler, Pflanzenr. 20: 102.

PLATE 1

Curcuma petiolata Roxb.

1904. *C. cordata* Wall. Pl. As. Rar. 1: 8, t. 10. 1829; Hook. f. in Bot. Mag. t. 4435. 1849. *C. kurzii* King ex Baker, l.c. 216. 1890, *syn. nov.*

Primary tuber small with a few sessile rhizomes, pale yellow inside; roots many, often with tubers at ends. *Leafshoots* 50-80 cm long, bearing 4-6 leaves; sheaths narrow, 20-30 cm long; petiole 8-15 cm long, slender; ligules rounded, 3-4 mm long; leaf-blade elliptic to oblong-elliptic, subequally rounded or subcordate at base, cuspidate-acuminate at apex, 25-35 cm long, 8-12 cm broad, glossy green above, pale green beneath. *Peduncle* slender, 15-28 cm long; spikes cylindric, cuneate at base, 8-12 cm long, 4-5 cm thick, floral bracts in 3-5 vertical rows, oblong-ovate, suborbicular and spreading at apex, connate for more than half way, 3.5-4.0 cm long, yellowish at base, pinkish orange at upper half; coma bracts few, ovate, subacute to obtuse, spreading, 3.5-4.0 cm long, brightly purplish orange. *Flowers* 2-5 in each cincinnus inside each bract-pouch, 3.0-3.5 cm long, creamy white; bracteole oblong, acuminate, boat-shaped, ± 3 cm long, ± 2 cm wide, white, glabrous. *Calyx* ± 8 mm long, acutely tridentate, minutely puberulous. *Corolla-tube* ± 2.5 cm long; lobes oblong-lanceolate, acute, subequal, 1.5-2.0 cm long, 0.8-1.3 cm wide, upper lobe concave, cuspidate. *Staminodes* oblong-lanceolate, ± 1.5 cm long, ± 1 cm wide. *Lip* deflexed, suborbicular, ± 1.3 cm long; obscurely trilobed, cream yellow with deep yellow median band; midlobe emarginate; lateral lobes erect, ± 6 mm long. *Filament* inserted at about $\frac{1}{4}$th above base of the anther, ± 3.5 mm long; anthers oblong, obliquely truncate at base, not spurred, ± 5 mm long, minutely puberulous; connective shortly produced with a crest. *Ovary* pubescent; stylodes erect, 4-5 mm long; style filiform, ± 2 cm long; stigma bilobed. *Fruit* obovoid, hairy, ± 1.5 cm long; seeds glossy brown, ± 4 mm long; aril white, partially enveloping seed. (Plate 1).

Flowering: July-October.

Specimens: N. ANDAMANS: Lakhmipur, common in inland forests, 23 Nov. 1976, *N. G. Nair* 4881 (PBL). M. ANDAMANS. Bakultala, dense shaded places amidst thick undergrowth in inland forests, 6 Nov. 1977, *Bhargava* 6406 (PBL); Mayabunder, edges of forests, 31 July 1974, *Bhargava* 1941 (PBL). S. ANDAMANS. Balooghat hill jungle, 7 July 1894, *King's Collector* s. n. Acc. no. 467215 (CAL); Baratang Island, 25 Oct. 1979, *P. Basu* 7351 (PBL); Coatering Cove, *Kurz* s. n. Acc. no. 467217 (CAL); Middle Point, Port Blair, *Kurz* s. n. Acc. no. 467218 (CAL).

Distribution: Burma and Andaman Islands.

Notse : The specimens from Andamans identified as *C. kurzii* at Calcutta herbarium were studied and found to be identical to *C. petiolata.* This species included by Baker under doubtful species in Flora of British India with a short diagnosis is treated here as a synonym of *C. petiolata.* This species grows in gregarious groups in primary inland forests and never seen in waste ground and is the only truly indigenous species of *Curcuma* in these islands. It is not seen in Nicobar group of islands so far. This is an addition to Flora of India, extending its distribution towards south of Burma.

4. **Curcuma zedoaria** (Christm.) Roscoe in Trans. Linn. Soc. 8: 354. 1807 et Monandr. Pl. Scitam. t. 109. 1825; Baker in Hook. f. Fl. Brit. Ind. 6: 210. 1890; K. Schum. in Engler, Pflanzenr. 20: 110. 1904; Ridl. Fl. Mal. Pen. 4: 254. 1924; Holtt. in Gard. Bull. Singapore 13: 71, f. 5. 1950; Wealth of India 2: 405. 1950; Backer & Bakh. f. Fl. Java 3: 71. 1968; Burtt in Gard. Bull. Singapore 30: 59. 1977. [*Kua* Rheede, Hort. Malab. 11: 13,

t. 7. 1692]. *Amomum zedoaria* Christm. & Panzer, Linn. Pflanzensyst. 5: 12. 1779; Plenck, Ic. Pl. Med. 2: 12, t. 11. 1789.

Detailed descriptions are available in literature.

Flowering: June-August.

Speciments : S. ANDAMANS. Ferrargunj — Jirkatang, collected in vegetative condition and flowered under cultivation on 3 June 1978, *Balakrishnan* 6746 (PBL).

Distribution: India, Malaya and Java.

Notes: Commonly seen in waste grounds in Andaman and Great Nicobar Islands. A new record for these islands. See Burtt (l.c. 1977) for typification and nomenclature of this species. This species can be cultivated as an ornamental garden plant, as it grows profusely and very quickly.

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35. AQUATIC KNOT WEEDS OF THE KASHMIR HIMALAYAS

(*With three plates*)

Aquatic knot weeds (320 species) represented by about 50 species with some doubtful varieties in the local flora, are of great interest to many people because they are aggressive invaders of lakes, reservoirs and other wet habitats and are capable of altering the ecological balance of large areas. In addition, they are taxonomically much complicated. Linnaeus (1753) included 26 species in the genus *Polygonum* L. Boisser (1879) divided the genus into 7 sections. Bentham and Hooker (1886) added 150 species and divided the genus into ten sections Jackson (1885) included 254 species and Hooker (1886) divided them into 11 sections. Tutin *et al.* (1964) and Cood and Cullen (1968) reduced the genus into 4-5 sections only. Small (1903) and Gross (1913) accepted the subdivisions of the genus *Polygonum* L. and treated its species as representing several genera. But due to the ambiguous nature of characters most of the authors in the last half century preferred to keep the genus undivided. (Bonner 1913, Danser 1927). However, during the last few decades the problem was reviewed and Hedberg (1946) and Hara (1966) clearly demonstrated more than one pollen morphotypes in the genus and divided it into few genera. In the present study the pollen morphotypes and the taxonomy of the existing species were studied which showed that the aquatic members of the present area fall in the genus *Persicaria* Mill. The pollen types differ from that of *Polygonum* s. str. in being tri — polyporate with murate reticulations. The aquatic species of the genus are:

Persicaria lapathifolia Gray	(= *Polygonum lapathifolium* L.)
Persicaria amphibia Gray	(= *Polygonum amphibium* L.)
Persicaria nepalensis Gross	(= *Polygonum nepalense* Meis).
Persicaria nodosa Opiz.	(= *Polygonum nodosum* Pers.)

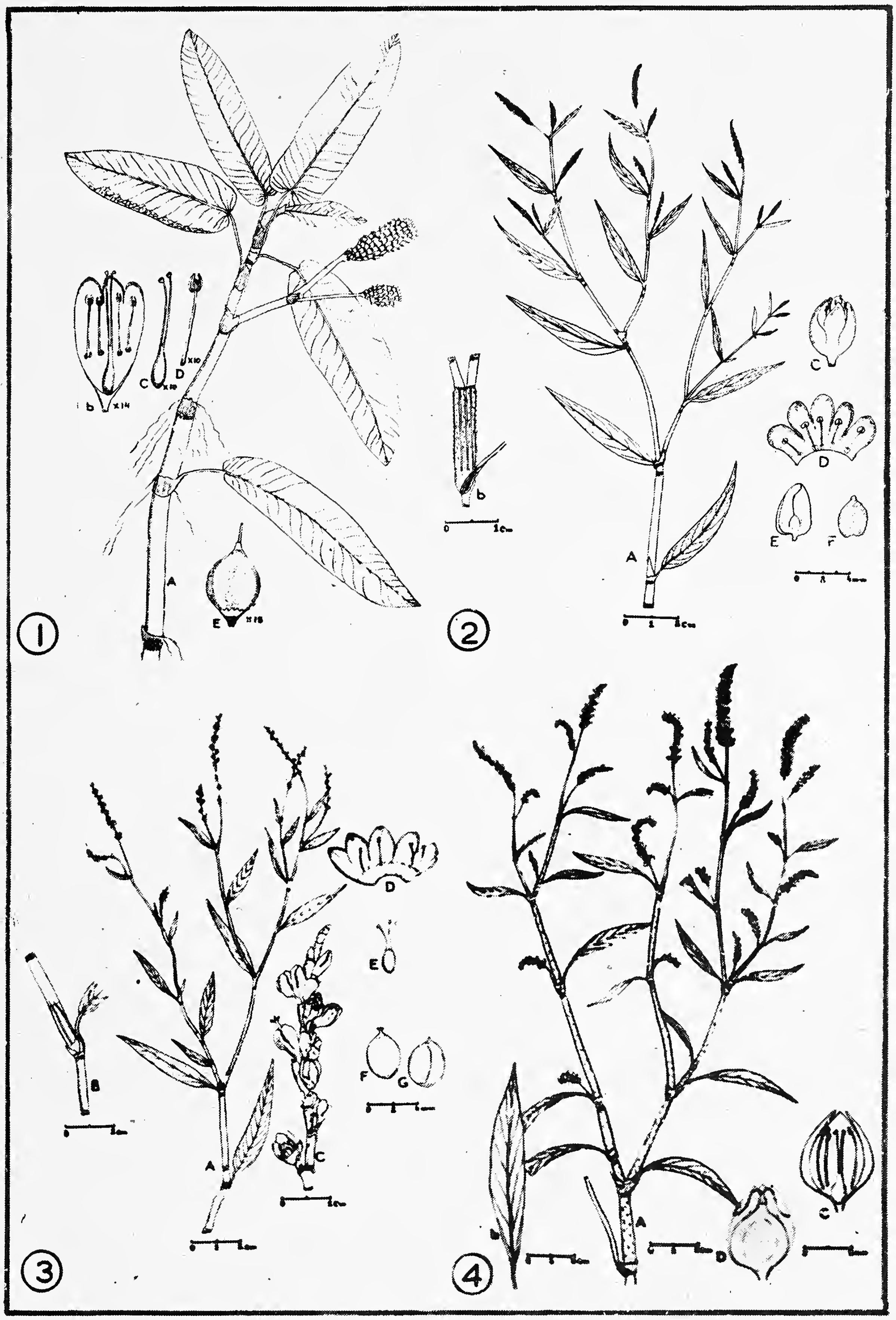


Fig. 1. *Persicaria amphibia* (L.) G.F. Gray: A. Habit; B. Flower showing the insertion of stamens; C. Ovary; D. Stamens; E. Mature nut.

Fig. 2. *Persicaria nodosa* (Pers.) Opiz.: A. Habit (upper portion); B. Ochrea; C. Flower; D. Petal dissected showing the arrangement of the stamens; E. Flower; F. Mature nut.

Fig. 3. *Persicaria punctata* (Elliot) Small.: A. Habit (Upper portion); B. Node showing the Ochrea; C. Portion of spike showing the arrangement of the flowers; D. Petals dissected showing the insertion of the stamens; E. Ovary; F-G. Mature nut showing variations.

Fig. 4. *Persicaria lapathifolia* (L.) S.F. Gray: A. Habit (showing upper portion); B. Leaf; C. Flower, l.s. showing the arrangement of the stamens; D. Mature nut enclosed in a perianth.

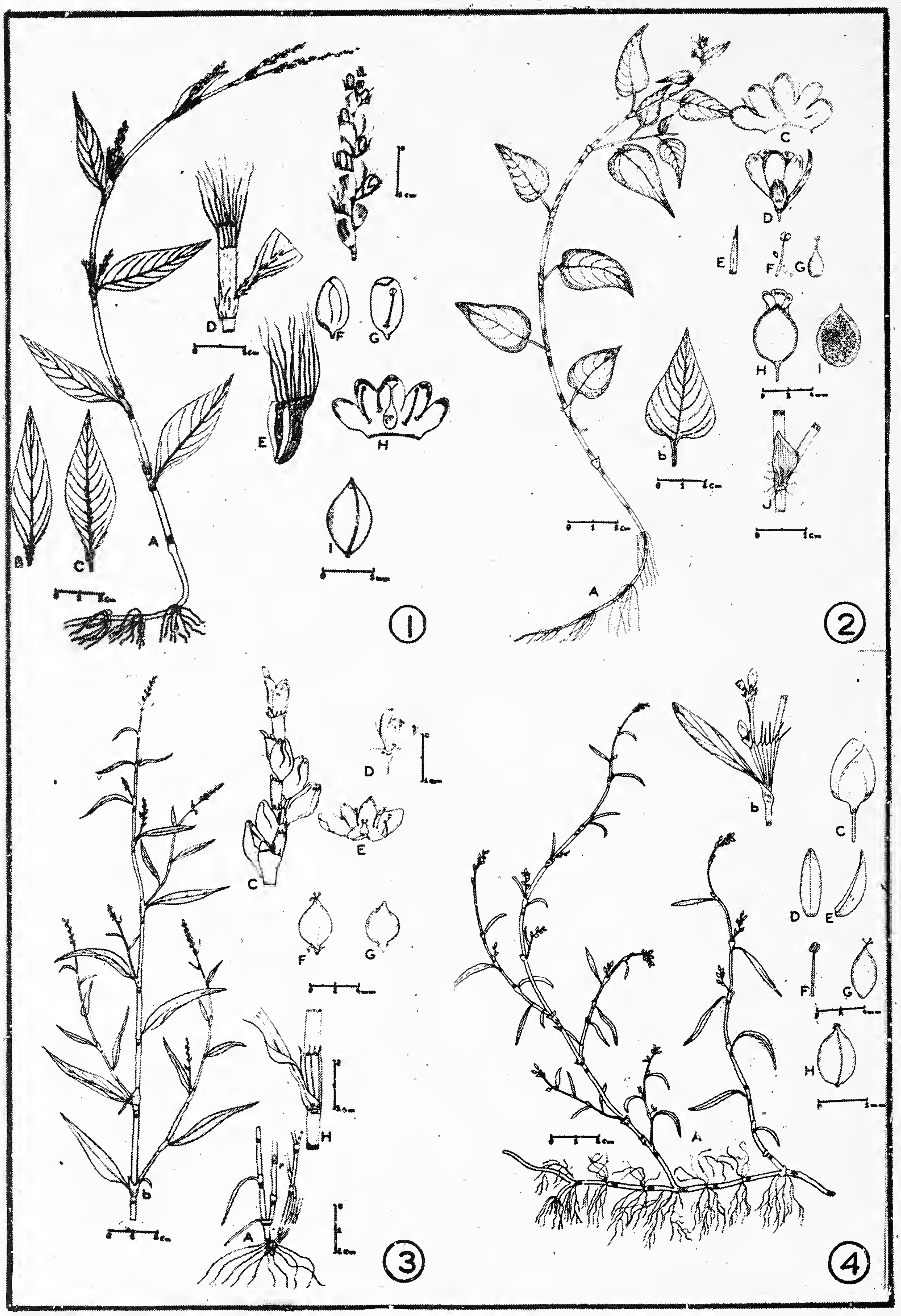


Fig. 1. *Persicaria hydropiper* var. *mite* (Schrank.) Majeed.: A. Habit; B-C. Leaf showing variation in size and shape; D. node with an ochrea; E. Ochrea showing long cilia; F. Flower; G-H. Petals showing the arrangement of the stamens and ovary; I. Mature nut; J. Portion of spike showing the arrangement of the flowers.

Fig. 2. *Persicaria nepalense* (Meissn) H. Gross.: A. Habit; B. Leaf. C. Corolla tube dissected; D. Flower; E. Involucral bract; F. Stamen; G. Ovary; H. Immature nut enclosed in perianth; I. Mature nut; J. Ochrea with cilia.

Fig. 3. *Persicaria hydropiper* (L.) Spach.: A. Lower portion of plant; B. Upper portion; C. Portion of spike showing the arrangement of the flowers; D. Flower arranged on the node; E. Corolla tube dissected; F. Immature nut; G. Mature nut; H. Node showing the ochrea and cilia.

Fig. 4. *Persicaria kawagoeana* (Makino) Nakai.: A. Habit showing decumbent nature and profuse roots; B. Node showing ochrea with cilia, floral spike and the leaves; C. Flower; D. Inner and E. Outer perianth; F. Stamens; G. Immature nut; H. Mature nut.

Persicaria hydropiper Spach	(= *Polygonum hydropiper* L.)
Persicaria kawagonena Nakai,	(= *Polygonum minus* Huds.)
Persicaria punctata Small,	(= *Polygonum punctatum* Elliot).
Persicaria hydropiper ssp. *mite* Majeed	(= *Polygonum mite* Schrank)

KEY TO THE SPECIES

1. Perianth segments 4-5 lobed; stamens not alternating with the glands. Pollen grains 3 colpate, colpi tapering both ends; exine with duplibacculate rods .... *P. nepalensis*
1. Perianth segments 4-5 partite; stamens alternating with glands. Pollen grains 3 — polyporate; pores brochal, ellipsoidal — oval; exine sometimes with multibacculate rods.
    2. Perennial, rhizomatous herbs; ochrea without cilia.
        3. Marshy; erect, internodes solid, red dotted. Leaves linear-lanceolate; spikes white or light pink, long, lax, branched, pendulous. Pollen grains 5 porate, lumina mostly granulate .... *P. lapathifolia*
        3. Aquatic; prostrate, decumbent, internodes fistular, smooth. Leaves dimorphic, mostly ovate, lanceolate; spikes reddish short, compact, never branched, erect. Pollen grains polyrugate; lumina with small bacculate rods... *P. amphibia*
    2. Annual: rarely perenating by stolens; ochrea fringed with cilia or bristles
        4. Spikes dense, stout with crowded or overlapping flowers .... *P. nodosa*
        4. Spikes lax, slender, flowers never crowded
            5. Steps sulcate; ochrea with 7-9 bristles; perianth segments eglandular. Seeds smooth...... .... *P. hydropiper*
            5. Stems smooth, ochrea without bristles; perianth segments glandular. Seeds lenticular
                6. Stems glandular, leaves sessile or subsessile punctate ventrally; perianth ovate...... .... *P. punctata*
                6. Stems glandular, leaves petiolate; never punctate perianth lanceolate
                    7. Ochrea with long cilia, leaves linear lanceolate stigma 3 fid. Lumina with bacculate rods .... *P. kawagoeana*
                    7. Ochrea with short or equal cilia, leaves broadly lanceolate, stigma 2-fid. Lumina mostly granulose .... *P. hydropiper* ssp. *mite*

PERSICARIA Mill. Gard. Diect. Abr. Ed. 4 (1754).

A cosmopolitan genus, represented by the following 8 aquatic or semi-aquatic species in this area. Some of the terrestrial species are endemic to the Kashmir Himalayas. Pollen grains colpate or porate (tritetracolpate or tripentaporate), mostly spherical, prolate, rarely subprolate in equatorial view, circular in polar view; colpi long reaching near the poles, more or less open without marginal thickenings; sexine thick may or may not be well differentiated into sexine and nexine; lumina mostly granulose or with small bacculate rods.

P. lapathifolia (L.) S. F. Gray. Nat. Arr. Br. Pl. 2: 270 (1821).

Polygonum lapathifolium L. Sp. Pl. 360 (1753); Hook. f. Fl. Brit. Ind. 5: 35 (1885).

Stout, prostrate perennial herbs, can be easily distinguished in the field: being bushy, steps red dotted, pubescent. Leaves narrowly lanceolate; upper ones sessile lower petiolate. Ochrea auricled, truncate, membranous; spikes lax axillary also terminal, branched or unbranched perianth fused at the base, broadly lanceolate, entire; styles 2. Seeds orbicular, with an apical beak 2.5 x 2 mm, with a central furrows, light

brown. Pollen grains 5 porate 21.9 x 21.6 μ, spherical in equatorial view circular in polar view; pores brochal, ellipsoidal, 1.8-2.7 x 1.7 μ; exine with multibacculate rods; rods 1.7-1.8 μ high; reticulations murate; muri 3.6-4 x 2-2.8 μ; lumina mostly granulate, sometimes with small bacculate rods.

Common in marshes near the sides of lakes and streams, also near wet meadows. Nagin lake AMK 660; Dal lake AMK 3811; Harwan AMK 3865.

Distribution. Himalayas, South west Asia, N. W. Africa, Europe.

P. amphibia (L.) S. F. Gray, Nat. Arr. Br. Pl. 2 : 268 (1821).

Polygonum amphibium L. Sp. Pl. 361 (1753); Hook. f. l.c. 34.

Prostrate, decumbent perennial herbs, can be easily distinguished in the field by having fistular internodes, trimorphic leaves; submerged ones ovate-ovate lanceolate, short petioled with cordate base; floating ones ovate, petiolate; upper ones oblong lanceolate; sessile. Ochrea tubular, truncate, parellel veined; spikes oblong, rosy red; perianth lanceolate, stigma capitate. Seeds orbicular, biconvex with an apical pointed end. Pollen grains polyrugate, 39 x 37.5 μ; spherical in equatorial view, circular in polar view; pores usually not visible; exine thick with multibacculate rods; rods 2-3 m high, reticulate, murate; muri 1.8-3.7 x 1.3-2 μ lumina mostly granulate.

Abundant in the lakes, irrigation canals, ditches, ponds and rivers. Also in marshes, swamps and in muddy wetlands, meadows. Common near the margins of floating islands. Anchar lake AMK 2024; Nowgam rakh AMK 663; Nagin lake AMK 3794.

Distribution. Cosmopolitan.

P. nepalensis (Meisn.) H. Gross in Engl., Bot. Jahrb. 49 : 277 (1913).

Polygonum nepalense Meissner. Monogr. Poly. 84. Pl. 7. f. 2. (1826); Hook. f. l.c. 41.

Prostrate annual, erect herbs, can be easily distinguished in the field by the hairy nodes. Leaves broadly ovate, acute, base truncate, hairy near the veins below. Ochrea membranous, hairy near the base. Perianth ovate, obtuse; stigma capitate. Seeds circular, biconvex, granular, dark brown. Pollen grains 3 colpate, 29.9-2.9 μ dia., spherical in equitorial view, circular in polar view; colpi medium — long, 12-14 μ high, tapering both ends; acute, exine with duplibacculate rods; reticulations murate; lumina with baculoid rods. Polar field index : 1:5.

Common in mud, at the edges of streams and ponds in the artificial reservoirs. Gulmerg AMK 3724 : Tangmerg (Ferozpur Nallah) AMK 2021.

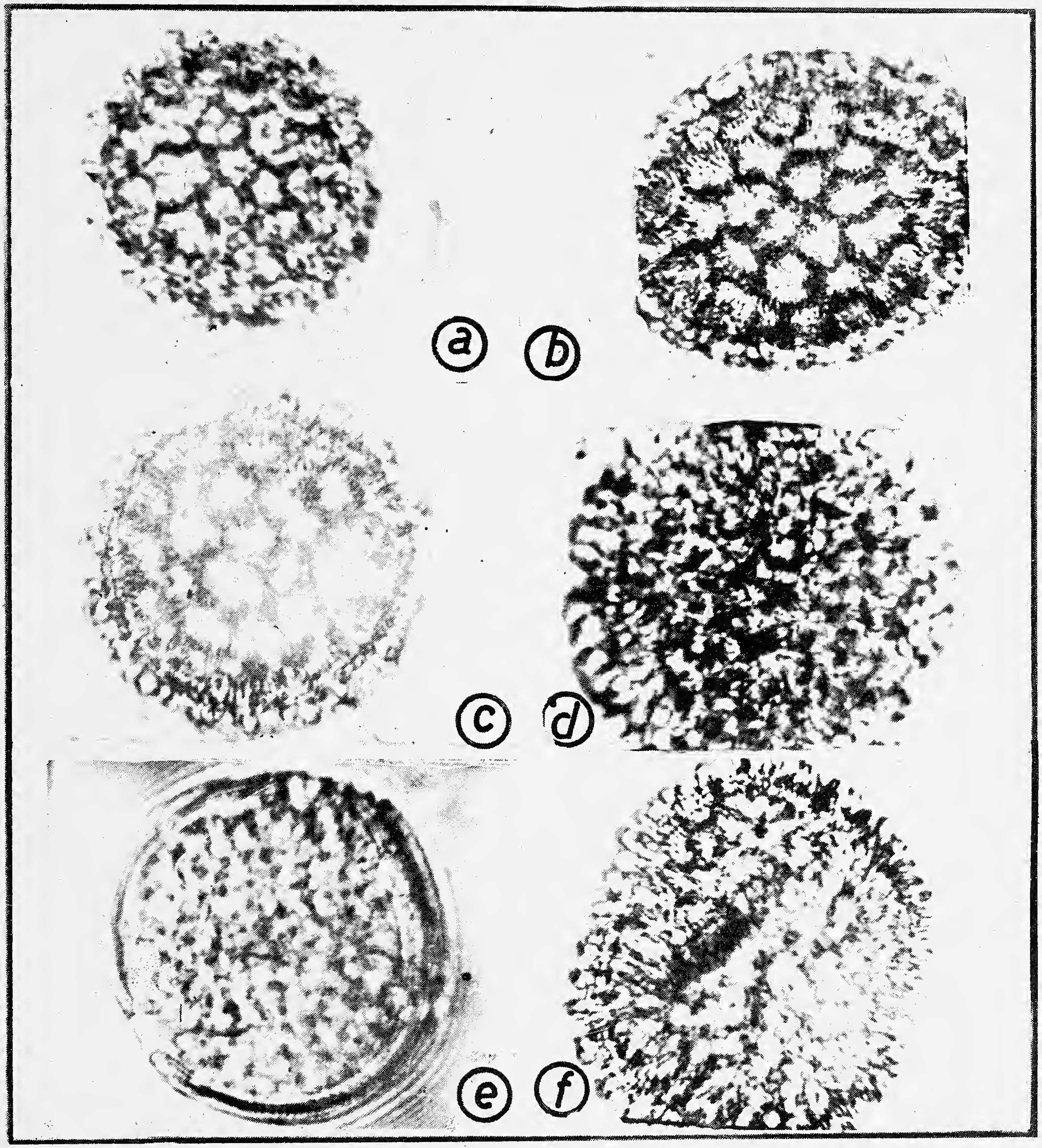
Distribution: Afghanistan, Himalayas from Kashmir to Sikkim, India, China, Japan, Malaya.

P. kawagoeana (Makino) Nakai in Rigakkai 24: 300 (1926): Ito in Jour. Jap. Bot. 31; 173, 177 (1956).

Polygonum minus Huds. Fl. Angle. ed. 1: 148 (1762); Hook. f. l.c. 36.

Dwarf, gregarious annual herbs, can be readily distinguished from other species of the genus in having straggling roots with bunch of secondary rootlets near the nodes; stems mostly documbent, Ochrea tubular, truncate with long cilia. Perianth lanceolate; stigma 3 lobed. Seeds trigonous, smooth, 2 x 1.5 mm, shining, dark red with a short apical beak. Pollen grains 5 porate, 26.5-27.4 × 25-26.9 μ dia. spherical in equatorial view, circular in polar view; pores brochal, ellipsoidal — oval, 5.49 x 3.68 μ; exine with dupli or multibacculate rods; reticulations murate; lumina with bacculate rods.

Abundant in marshes, bogs in shallow water on the edges of ponds, lakes and streams.



Polynograph of the genus *Persicaria* Mill.: a. *Persicaria hydropiper* (L.) Spach.; b. *Persicaria nodosa* (Pers.) Opiz; c. *Persicaria lapathifolia* (L.) Gray; d. *Persicaria kawagoeana* (Makino) Nakai; e. *Persicaria amphibia* (L.) Gray; f. *Persicaria nepalense* (Meissn.) Gross.

Shalimar AMK 2071, Harwan AMK 3793; Suderbal AMK 3681.

Distribution. Europe, Tropical and Temperate Asia, India, Sri Lanka and Kashmir.

P. punctata (Elliot) Small. Fl. S.E.U.S., 379 (1903).

Polygonum punctatum Elliot. Bot. S. C. and Ca. 1: 445 (1817). *P. acre* H.B.K. Nov. Gen. and Sp. 2: 177 (1817).

Erect or decumbent herbs, superficially close to *P. hydropiper* but the racemes are often erect and not nodding. Stems often glandular punctate. Leaves lanceolate or ovate lanceolate, cunate. Ochrea cylindrical, expanding with the node, glandular dotted, truncate, ciliate. Perianth ovate, conspicuously glandular; styles 2-3 fid. Seeds lenticular, trigonous 1.8-2.5 mm long, shining, dark brown or black. Pollen grains poly-pentaporate, 24-25.6 x 23-24 μ dia. spheroidal in equatorial view, circular in polar view; pores ellipsoidal 4-4.5 x 2-3 μ dia., exine with multibaculate rods; reticulations murate; lumina with small baculoid rods.

Near wet and muddy places in shallow waters, ponds and ditches, in the paddy fields. Hokhar sar AMK 3211, Gulmarg AMK 3682; Ferozpur Nallah AMK 3796.

Distribution. Himalayas, Tropical Africa.

P. nodosa (Pers.) Opiz. Seznan. 72 (1852).

Polygonum nodosum Pers. Meissner. in DC. Prodr. 14: 118 (1856).

Simple or branched herbs, rarely forming mats like *P. kawagoeneana.* Nodes thick, leaves lanceolate gradually narrowed towards the base, wavy, somewhat hairy and glandular at the base. Ochrea loose, sharply fringed, hairy. Perianth broadly ovate, styles 2 deeply incised. Seeds roundly ovoid, compressed 2 x 3 mm, 2 angled, smooth, shining, black. Pollen grains 3-5 porate, 60 x 45 μ, subprolate in equatorial view, circular in polar view; pores brochal; ellipsoidal — oval, 5.49-3.68 μ; exine with dupli- or multibaculate rods; reticulations murate; muri 10.8-12 × 7.32 × 15 μ; Lumina coarsely granulose.

Near wet and muddy places, and bogs. Panikar (Zanaskar, Ladakh) AMK 3125; Drass (Ladakh) AMK, 3810, 3864.

Distribution: S. W. Asia, Africa and Europe.

P. hydropiper (L.) Spach, Hist. Veg. 10; 538 (1841).

Polygonum hydropiper L. Sp. Pl. 361 (1753): Hook. f. l.c. 39.

Common weed of paddy fields, stems ribbed. Leaves linear lanceolate, sessile or subsessile. Ochrea truncate with 7-9 bristles. Spikes interrupted, loose. Perianth fused at the base, ovate lanceolate brown dotted ventrally; styles 3. Seeds ovate, trigonous 3 x 2 mm, with an apical pointed end, dark brown, smooth. Pollen grains 5-polyporate, 55.5 x 52.5 μ dia., spheroidal in equatorial view, circular in polar view; pores brochal, ellipsoidal — oval, 5-5.5 x 1.8-2 μ; exine with multibaculate rods, rarely crenate, reticulations murate; lumina mostly granulose and rarely with small baculoid rods.

Abundant in rice fields, sides of streams, near wet meadows, and in pasture lands, Nishat, AMK 3303; Hokhar sar AMK 3795; Bemna AMK 3809.

Distribution: Temperate Asia, North America and Europe.

P. hydropiper ssp. **mite** (Shrank) Majeed. Comb. nov.

Polygonum mite Schrank, Bayr. (Bair) 1: 668 (1789).

Erect or decumbent, rooting at the base and on upper few nodes. Leaves broadly lanceolate. Ochrea truncate, cilia equal or much longer than ochrea; spike lax, rarely leafy; style bifid. Seeds broadly ovate, trigonous or 2 angled, shining smooth, brown. Pollen grains similar to that of *P. hydropiper,* except in the size of the exine.

Common in the marshes, swamps and in muddy wet meadows. Harwan AMK 4015; Ganderbal AMK 3745.

Distribution. Europe, Asia minor, Himalayas.

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December 27, 1981.

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A. MAJEED KAK

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36. A NOTE ON THE OCCURRENCE OF A FEW UNCOMMON PLANTS IN W. BENGAL

INTRODUCTION

While collections of economic plants and plant-products were made from western Duars of Jalpaiguri district (W. Bengal) during the month of April-May and November, 1981, we could collect a few uncommon rare plant species from the plains of North Bengal. A perusal of available literature and herbarium specimens in the herbaria (CAL & BSIS) revealed that these taxa sporadically grow in W. Bengal and in the recent past their occurrence in the locality has not been reported. So, we are trying to draw the attention of Botanists for their immediate conservation before the concerned taxa are eliminated from the flora of W. Bengal. The plants are described here with correct nomenclature, diagno-

stic characters and field data. The herbarium specimens are deposited in the economic plants herbarium of Industrial Section (BSIS), Botanical Survey of India, Calcutta.

ENUMERATION

Cucurbitaceae

Hodgsonia macrocarpa (Bl.) Cogn. in DC. Monogr. Phan. 3 (1881) 349; Hara, H. Fl. E. Himal. (1966) 323. *H. heteroclita* Hook. f. and Thom., Clarke in Hook. f. Fl. Brit. India 2 (1879) 606; Chakravarty, Ind. Journ. Agric. Sc. 16 (1946) 15, Monogr. on Indian Cucurbitaceae (1959) 27. *Trichosanthes macrocarpa* Bl. Bijdr. (1826) 935.

Large climber; stem robust, angular, glabrous. Leaves broad, 3-5 lobed, upper surface bright green and lower light green, both surfaces glabrous, base truncate or emarginate, petiole robust, striate, glabrous or puberulous, 5-8 cm. long. Tendril robust, glabrous, usually bifid. Male peduncle generally short, thick, striate, glabrous or puberulous, 15-30 cm. long; pedicels short and thick; bracts fleshy oblong-lanceolate, 0.5-1 cm. long. Calyx tube yellowish, glabrous, 8-10 cm. long, 7-9 mm. broad. Corolla yellow outside, white inside; lobes 3-nerved, 5 cm. long, fimbriate; fringes upto 15 cm. long.

Distribution. E. himalaya (Sikkim), Assam, Burma, Malaysia and S. W. China.

Chakravarty (1959) has mentioned its occurrence in Darjeeling citing only one herbarium specimen of Anderson 555 (CAL) whereas Hara (1966 has only reported its occurrence from two places (Sikkim) of E. himalaya. Chakravarty (1959) also has cited other two herbarium specimens of Lister S. N. (CAL) and Gamble 7786 (Kew) collected from Rangamati and Kamalasene of Chittagong hill tract but the area is now in Bangladesh. So, it may be concluded that the taxon is very rare in W. Bengal so that it could not be collected by other Botanists until the recent collections by us from the plains of West Bengal.

Specimens examined — H. B. C. 473, March 1932 (CAL); K. Biswas 4928, Latherai (Tippera) 1941 (CAL); V. Narayanaswami and party 2325, 21 miles from Rajabhatkhawa (Jalpaiguri) (CAL); S. N. D. and S. C. Roy 3610, Titi-forest (Jalpaiguri), 23.4.1981 (BSIS).

Gomphogyne cissiformis Griff. Pl. Cantor. (1837) 26 in adnot. t. 4; Cogn. in DC. Monogr. Phan. 3 (1881) 924, in Engler's Das Pflanzenr. 4. 275. 1 (1916) 38; Clarke in Hook. f. Fl. Brit. India 2(1879) 632; Chakravarty, Monogr. Indian Cucur. (1959) 184-186; Hara, H. Fl. E. Himal. (1966) 322-323.

Small slender and scandent herb, glabrous or slightly puberulous especially at the nodes. Leaves petiole slender, glabrous, 3-6 cm. long; lamina finely membranous, upper surface bright green, lower dull green, both surfaces glabrous and smooth; base narrow, margin crenate-dentate; teeth subround, mucronate; middle leaflet 4-6 cm. long, 1-2 cm. broad; lateral leaflets shorter. Tendril filiform, elongate, glabrous. Male racemes simple or branched; main rachis slender, flexuose, glabrous, 10-30 cm. long or longer, pedicels capillary, often fasciculate, flexuose, glabrous, 1-3 mm. long; base minutely bracteolate. Sepals narrow, acute, 1-1.5 mm. long. Petals glabrous, trinerved; margin entire or obscurely denticulate, 2.5-3 mm. long, about 1 mm. broad.

Distribution. Himalaya (Garhwal to Sikkim), Malaya, Indochina, S. W. China and Philippines.

Cowan and Cowan (1929) have not mentioned its occurrence in North Bengal. Chakraborty (1959) has referred only one herbarium specimen of Gamble 8522 (CAL) collected

from Darjeeling (7000 ft.) in the range of E. himalaya, whereas Hara (1966) has collected the plant from Nepal only. The authors have also noted with great interest that the occurrence of this plant in West Bengal is very rare and after several decades they have collected the plant from the plains of W. Bengal for the first time. Specimen examined — B. B. Osmastre (S. N.), Lepchajagat (7000 ft.), Darjeeling, 1903 (CAL); S.N.D. & S.C.R. 3558 (♂), on way to Gaidham (Seurani forest), Jalpaiguri, 20.4.1981 (BSIS).

Verbenaceae

Clerodendron wallichii Merrill in Journ. Arn. Arb. 33 (1952) 220; Hara, H. Fl. E. Himal. (1966) 269. *C. nutans* (non Jack) Wall. ex D. Don, Prodr. Fl. Nepal (1825) 103; Prain, D.B.P. 2 (1903) 623; Hook. f. Fl. Brit. India 4 (1885) 591.

A tall shrub, glabrous. Leaves 20-16 cm. long, 3-5 cm. broad, narrowly obovate or lanceolate, subentire, much acuminate; base attenuate; petiole short. Inflorescence panicle, very lax, few flowered, bracteate; bracts filiform. Calyx green, becomes red in fruit. Corolla white or light violet; tube 1.28 cm.; lobes 1.25 cm., obovate. Drupe succulent, dark purple.

Distribution. Himalaya (Sikkim), Assam to Chittagong, Burma and Indochina.

Prain (1903) has reported this plant from Chittagong which is now under Bangladesh.

Cowan and Cowan (1929) has recorded its occurrence in North Bengal without citing its actual place of collection and referring any specific herbarium specimens. Hara (1966) has collected the plant only from Nepal. We also have not found any herbarium specimens of W. Bengal inspite of thorough search in the herbaria (CAL and BSIS). But we have collected this plant from Jalpaiguri district. So, the plant is treated as very rare and its occurrence in the plains of W. Bengal recorded for the first time.

Specimen examined — S. N. D. & S.C.R. 3784, Titi forest, Jalpaiguri, 6.11.81 (BSIS).

Euphorbiaceae

Glochidion sphaerogynum Kurz, For. Fl. Burma 2 (1877) 346; Deb. D. B. Bull. Bot. Surv. India 3 (1961) 290; Prain, D. Beng. Pl. 2 (1903) 697; Hook. f. Fl. Brit. India 5 (1890) 317.

A medium-sized or small tree. Leaves 5-15 cm long, 1.4-3.5 cm. broad, lanceolate, acuminate; base oblique. Flowers clustered; male flowers small, pedicelled; female flowers subsessile. Capsules subsessile, 8-12 lobed with large globose style in the depressed apex in conjested fascicles.

Distribution. Eastern tropical himalaya (Sikkim & Bhutan), Chittagong, Burma and from Peru to Tenasserin.

Prain (1903) has reported this plant from Chittagong which is now in Bangladesh. Cowan and Cowan (1929) and Hara (1966, 1971 & 1974) have not reported this plant from any part of W. Bengal. So, the occurrence of this plant in W. Bengal is treated as very rare and the present report of its occurrence is the first record.

Specimens examined — S. K. Mukherjee 5604, Apalchand, Kathambari, Jalpaiguri, 1962 (CAL); H.B.C. (CAL), S.N.D. & S.C.R. 3534, Gayatring, Totopara, Jalpaiguri, 18.4.81 (BSIS).

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CALCUTTA-700 013,
July 3, 1982.

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37. NOTES ON *VIOLA BETONICIFOLIA* J. SM. *SENSU LATO* IN INDIA

(*With a text-figure*)

V. betonicifolia sensu lato (Sect. Nominium Ging., sub-sect. *Adnatae* W. Beck.) includes three sub-species — ssp. *betonicifolia*, ssp. *jaunsarensis* and ssp. *nova-guineensis.* W. Becker (1917) included under *V. betonicifolia* s.l. a series of populations ranging from the north-west Himalayas to eastern Siberia and south-west to southeast Australia. Within this he recognised *V. betonicifolia* ssp. *australensis* W. Beck., (*nomen illegit*, ssp. *betonicifolia*), *V. betonicifolia* ssp. *nepaulensis* (Ging.) W. Beck. and *V. patrinii* DC. The whole complex is united in the possession of short, undifferentiated calycine appendage, short spur on lower petal, clearly bearded lateral petals and short, dark coloured stipules.

The commonest of the Violas occurring in hilly regions throughout India which has generally been identified as *V. patrinii* is *V. betonicifolia* ssp. *betonicifolia. V. betonicifolia* ssp. *nepalensis* (DC.) W. Beck. is now being included in ssp. *betonicifolia* which appears from the study of a photograph of the holotype of ssp. *nepalensis* in the British Museum (BM). The holotype of *V. patrinii* DC. from Siberia (G-DC) has been examined *V. patrinii,* which is considered here restricted to Siberia, Manchuria and N. Japan, as also by W. Becker (1917) and Hara (1975) is distinguished from *V. betonicifolia* by the following characters:

Rhizome light brown. Flowers 1-2 cm across. Spur 2-6 mm .... *V. betonicifolia*

Rhizome dark brown to deep violet. Flowers upto 1 cm across. Spur up to 2 mm......... *V. patrinii*

The plant occurring in the Western Himalayas with larger flowers, larger spurs and ovate-oblong to lanceolate leaves is *V. betonicifolia* ssp. *jaunsarensis* (W. Beck.) Hara. *V. patrinii* var. *suaveolens* Watt. and *V. kashmiriana* W. Beck. belong to the same race, being connected by a series of intermediate forms.

V. betonicifolia ssp. **nova-guineensis** D. M. Moore (1963) is restricted to Timor and New-Guinea (Type from Asaro Valley, Goroka, New Guinea, 15.6.1956, *Hoogland* and *Pullen* 5337 in CANB, photo !).

It differs from ssp. *betonicifolia* and ssp. *jaunsarensis* in bearing triangular — hastate leaves with basal lobes laterally prominent and long decurrent on petiole, which is normally

more than twice as long as lamina.

V. betonicifolia J. Sm. in Rees., Cyclop. 37 : *Viola* n. 7. 1819.

Perennial. Root stock ± articulated. Stems or stolons O. Leaves in rosette, variable; lamina 1.5-8 × 0.5-3 cm, ovate-oblong, deltoid-ovate to lanceolate, cuneate, truncate or widely to shallowly cordate with basal lobes hastate to ± sagitate, roundish-obtuse to ± sub-acuminate, crenate with rounded or blunt teeth or rarely ± serrate; petioles 2-10.5 cm; ± winged above. Stipules 0.5-1.5 cm, ovate-lanceolate, acuminate, sparsely dentate, adnate up to above the middle point. Peduncles equalling or exceeding leaves. Flowers 1-2 cm across, white to purple. Sepals 4-8 mm, ovate to ovate-lanceolate, acute or acuminate, appendage up to 2.5 mm, rounded. Petals up to 1.5 cm, obovate-oblong, laterals usually bearded at the base; spur 2-6 mm, cylindrical, straight or slightly upcurved. Style 3 mm ± geniculate at base, clavate above; stigma triangular-marginate, shortly beaked. Capsule up to 1 cm, ellipsoid to oblong, glabrous.

1a. Lamina linear lanceolate to triangular ovate; flowers up to 1.5 cm across, spur 2-4 mm.... .... ssp. *betonicifolia*

1b. Lamina ovate oblong to broadly lanceolate; flowers 2 cm across, spur 5-6 mm........... .... ssp. *jaunsarensis*

1a. ssp. **betonicifolia** — *V. betonicifolia* J. Sm. in Rees., Cyclop. 37: *Viola* no. 7. 1819; Jacobs et D. M. Moore in Fl. Males. 7: 202. 1971; Hara in Bull. Univ. Mus. Univ. Tokyo 8: 82. 1975. *V. betonicifolia* J. Sm. ssp. *australensis* W. Beck. in Engl. Bot. Jahrb. Beibl. 120, 54: 166. 1917, *nom. illegit. V. betonicifolia* J. Sm. ssp. *nepalensis* (Ging.) W. Beck. in Engl. Bot. Jahrb. Beibl. 120, 54 : 167. 1917. *V. patrinii* DC. var. *nepalensis* Ging. in DC. Prodr. 1: 293. 1824. *V. patrinii* sensu Hook. f. & Thoms. Fl. Brit. Ind. 1: 183. 1872. *pr. max p.*

Lamina 2-8 x 1-3 cm, deltoid-ovate to linear lanceolate, deeply to shallowly crenate, subcordate or truncate at the base, glabrous to more or less pubescent; petioles 4-10 cm, usually winged above. Peduncles 5-15 cm, bi-bracteolate at the middle. Flowers up to 1.5 cm across, lilac. Sepals 4-6 mm, lanceolate. Petals up to 1 cm, obovate-oblong, laterals bearded at the base; spur 2-4 mm.

Flowering. January to April. *Fr.*: March to June — often extending throughout the year.

Type. Botany Bay, Port Jackson, N. S. Wales, Australia, *Dr. White* ? n.v.

Specimens examined. INDIA: ARUNACHAL PRADESH: Forest around Parasuram kund, Lohit Dist., *J. Joseph* 48868 (CAL); Janakmukh, Abor Expedition, *I. H. Burkill* 37144 (CAL); Rami dam bank, Abor Expedition, *I. H. Burkill* 36403 (CAL); Yambung camp, Bank of Dihong, Abor Expedition, *I. H. Burkill* 36022 (CAL); Renging, Abor Expedition, *I. H. Burkill* 37323 (CAL); Daphla Hills, *J. L. Lister* 114 (CAL); Chenhang, Tiap F. D., *D. B. Deb* 26193 (CAL); Kalaktang, Kameng F. D., *G. Panigrahi* 15571 (CAL); Tuting, Siang F.D., *R. S. Rao* 17319 (CAL); Sissini camp, Kameng F.D., *G. Panigrahi* 5956 (part) (CAL); Petepool, Subansiri F.D., *G. Panigrahi* 19705 (CAL); Rupa I. B., Kameng F.D., *G. Panigrahi* 6625 (CAL); Jabrang, Kameng F. D., *G. Panigrahi* 6524 (CAL); Sadiya, Lohit F.D., *G. A. Gammie* 243 (BSI); ASSAM: Dibrugarh, Assam, *King's collector s.n.* (CAL, Acc. 30940); Couhatty, Assam, *Simon s.n.* (CAL, Acc. 30746), part; Sibsagar, *Without collector's name s.n.* (CAL, Acc. 30950); Mahurtula, Assam, *N. Gill* 128 (CAL); Lumdirin village, 1½ miles from Moirang, *G. Panigrahi* 16281 (CAL). BIHAR: Behar, *S. Kurz s.n.* (CAL, Acc. 30928). HIMACHAL PRADESH: Chini, (Kinnaur), *N. C. Nair* 22407

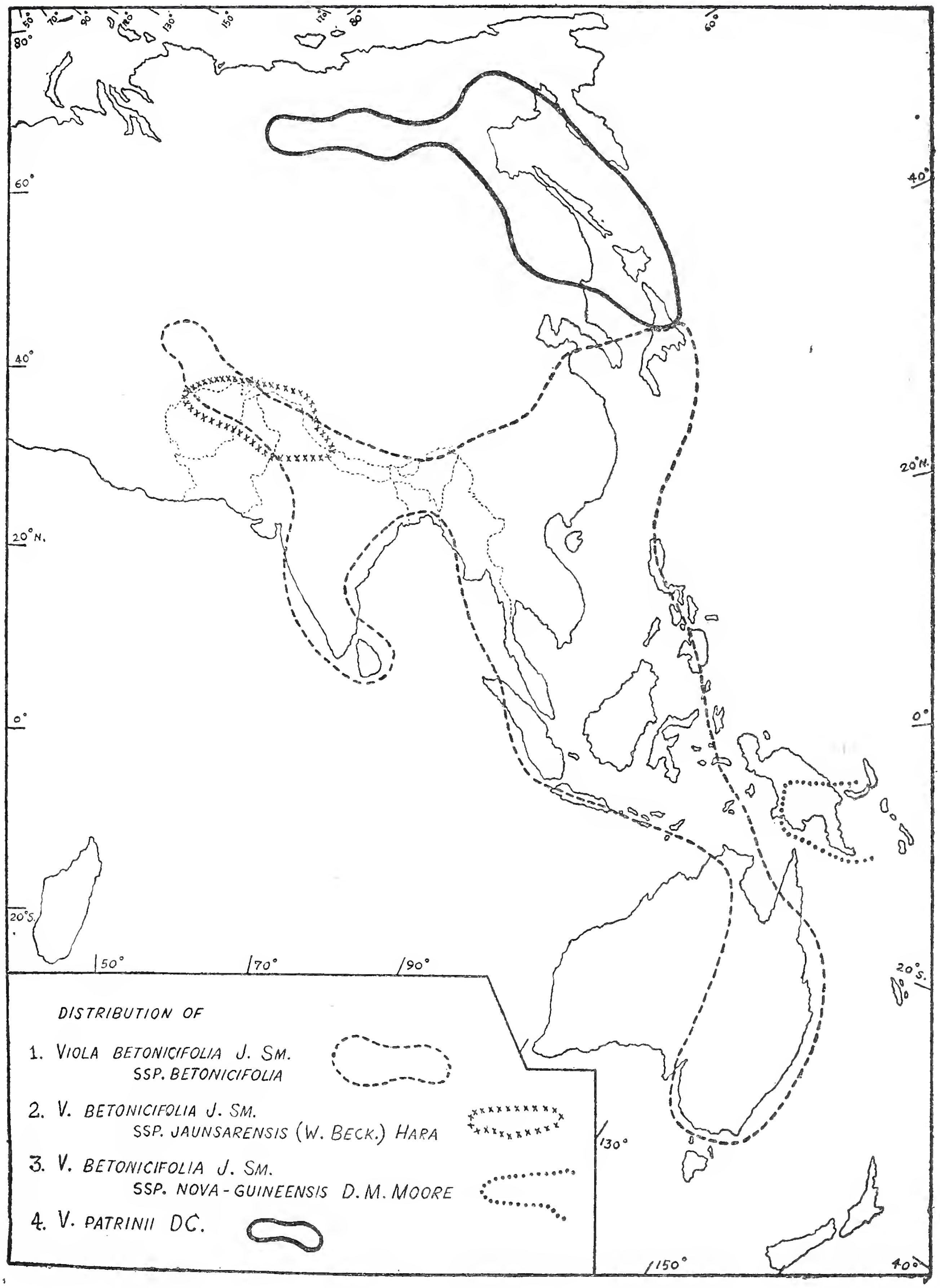
DISTRIBUTION OF
1. VIOLA BETONICIFOLIA J. SM. SSP. BETONICIFOLIA
2. V. BETONICIFOLIA J. SM. SSP. JAUNSARENSIS (W. BECK.) HARA
3. V. BETONICIFOLIA J. SM. SSP. NOVA-GUINEENSIS D. M. MOORE
4. V. PATRINII DC.
50°
70°
90°
130°
150°
60°
40°
20° N.
0°
20° S.
80°

Fig. 1

(CAL); Shahpur, near Kangra, *A.R.E.P.* 15253 (CAL); Kangra, *A. R. E. P.* 15458 (CAL); Simla, *A. C. s. n.* (Acc. 30752) (DD); Kulu, *K. D. Bagchee s.n.* (Acc. 53847) (DD); JAMMU & KASHMIR: Kalunta Dharggr, *K. S. Ahluwala* 1744 (CAL); Gilgit, *J. F. Duthei s.n.* (CAL); Didderwart, Kashmir, *B. M. Wadhwa* & *J. N. Vohra* 294 (CAL); Kashmir, Thaphyal, *H. D.* 26540 (DD). KARNATAKA: Kulhutty, Bababood, *A. Meebold* 9547 (CAL); Bababuden hills, Mysore, *W. A. Talbot* 2348 (CAL); Bababooden Hills, Mysore, *W. A. Talbot* 2348 (BSI); Kemanggandishimoga, *B. S. Ahuja* 65603 (BSI); KERALA: Rajamallay, Deviecolam, Kottayam Dist., *B. V. Shettey* 33430 (CAL); Way to top station, Kottayam Dist., *D. B. Deb* 30812 (MH). MADHYA PRADESH: Pachmari, *J. F. Duthei* 10. 308 (CAL); Jabbalpore, *Without Collector's name* 31969 (CAL); MANIPUR: Myong Khong, Manipur, *G. Watt* 6031 (CAL); Kanglatonghi, *A. Meebold* 5422 (CAL); Ukhrul, *S. K. Mukerjee* 2424 (CAL); Keithemabi, Manipur, *G. Watt* 5837 (BSIS). MEGHALAYA: Shillong, Khasia Hills, *C. B. Clarke* 6072 (CAL); Dumpep, Khasi Hills, *I. H. Burkill* and *S. C. Banerjee* 34254 (CAL); Between Shillong & Dumpep, Khasi Hills, *I. H. Burkill* and *S. C. Banerjee* 338 (CAL); Myrang. Near Nunglung, *Without Collector's name* 817 (CAL). MIZORAM: Lushai Hills, *Mrs. N. F. Parry s.n.* (CAL). NAGALAND: Piphema, Naga Hills, *H. Collett* 162 (CAL); Jaboca, Naga Hills, *M. A. Hock* (*Prain's Collector*) 107 (CAL). ORISSA: Mahendragiri, Ganjum, *Fischer* & *Gage* 7 (CAL); Mahendragiri, Ganjum, *V. Narayanaswami* 5740 (MH); Kuthadya Hills, Ganjum, *V. Narayanaswami* 5900 (MH); Surguija state, Orissa, *Mooney H. F.* 2848 (DD), RAJASTHAN: Sunset Hill, Mount Abu, *K. S. Ahluwala* 243 (BSI). TAMIL NADU: Saryatimalai forest, Salem, *V. Narayanaswami* & *Party* 1390 (CAL); Upper Palnis, *C. E. C. Fischer* 2895 (CAL); Madras, *Rev. Aug. Sauliers* 93 (CAL); Shambaganur, *Rev. Aug. Sauliers* 28 (CAL); Conur, *G. King* 1046 (CAL); Pulney Hills, *Without Collector's name s.n.* (MH, Acc. 1214); Yercaud, Salem, *A. V. N. Rao* 26944 (MH); UTTAR PRADESH: Moralle, *E. R. Johnson s.n.* (CAL, Acc. 30669); Kumaon, *Anderson s.n.* (CAL, Acc. 30672); Harbanswala Tea Estate, Dehra Dun, *N. P. Singh* 25464 (BSD); Niranjanpur, Dehra Dun, *N. P. Singh* 25459 (BSD); Thal, Kumaon, *C. M. Arrora* 36414 (BSD); Deolsari, Tehri-Garhwal, *U. C. Bhattacharyya* 33792 (BSD); Dehra Dun, *H. B. Naithani* 8 (DD); Mussorie, *H. O. Saxena* s.n. (DD, Acc. 140015). WEST BENGAL: Terai *Ribu* & *Rhomoo s.n.* (CAL); Sookna, *Ribu s.n.* (CAL); Shummui Danga, Darjeeling, *J. S. Gamble* 1055 (CAL); Torsa (Terai), *Ribu* & *Rhomoo* 3839 (CAL).

General Distribution. Afghanistan, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh, China to South Japan, Burma, Malaysia to Australia (Fig. 1).

Plants medicinal — bruised and applied to ulcers and foul sores. Flowers in China, Indo-China and Malaya said to purify blood (Chopra *et al.* in *Gloss. Med. Pl.* 255. 1956 — as *V. patrinii*).

Chromosome reports: 2n = 48, 72 (Moore in Fedde, Rep. 68: 84. 1963); 2n = 24 (Miyaji in Cytologia 1: 28-58. 1929).

1b. **V. betonicifolia** J. Sm. ssp. **jaunsarensis** (W. Beck.) Hara in J. Jap. Bot. 49(5): 133. 1974. *V. prionantha* Bunge, Enum. Pl. China 82. 1831 ssp. *jaunsarensis* W. Beck. in Engl. Bot. Jahrb. Beibl. 120, 54: 181. 1917. *V. patrinii* DC. var. *suaveolens* Watt in J. Linn. Soc. 18: 379. 1881. *V. kashmiriana* W. Beck. in Engl. Bot. Jahrb. Beibl. 120, 54: 182. 1917.

Lamina 2-5.5 x 1-3 cm, ovate oblong to broadly lanceolate, ± hirsute, truncate, subcordate or cordate at base, crenate-serrate, obtuse to sub-acuminate, petioles 2-8 (-12) cm. stipules 1-1.5 cm, oblong-acuminate, shortly dentate. Peduncles up to 8 (-12) cm, bi-bracteolate at or slightly below the middle. Flowers 2 cm across. Sepals 8 mm, oblong, acute. Petals 1.5 cm, obovate oblong, laterals bearded at base, spur 5-6 mm, cylindric, recurved. Capsule 8 mm, ellipsoid.

Fl. & Fr.: April-July.

Type ssp. *jaunsarensis* — Konain, Jaunsar, *J. F. Duthei* 12963 (CAL — holo ! BM — iso !).

Specimens examined. INDIA: HIMACHAL PRADESH: Theong, Simla hill state, *I. H. Burkill* 28635 (CAL); Chamba state *J. H. Lace* 717 (CAL); Bashahr, *J. H. Lace* 688 (CAL); Martiana, Simla Hill state, *I. H. Burkill* 28682 (CAL); Rotang Pass, *Stoliczka s.n.* (CAL, Acc. 31027); on the ascent to the Sach Pass, Chamba state, *G. Watt* 970 (CAL); Nagkanda forest, Chamba. *G. Watt* 686. 970 & 2097 (BSIS); Begi. Simla, *G. Watt* 93 (BSIS); Phagu, Simla, *H. G. Carter* E. B. 577 (BSIS); Dainkund, Chamba state, *J. H. Lace* 1529 (BSIS). JAMMU & KASHMIR : Karakoram Glaciers, *W. M. Conway* 309 (CAL); Purti, Chenab Valley, *Robert Ellis* 1126 (CAL); Mulluk and Lout of Bhabehpass, *Stoliczka s.n.* (CAL, Acc. 34033). UTTAR PRADESH : Kaltuan, Jaunsar, *J. S. Gamble* 25412 (CAL); Bodyar, Jaunsar, *C. A. Webb.* 13 (BSIS); Jaunsar, *J. F.* Duthie 12963 (DD).

General Distribution. Afghanistan, Pakistan. (Fig. 1).

The type sheet of *V. patrinii* var. *suaveolens* in Herb. *BSIS* with G. Watt's annotations consists of specimens under the different field nos. 686, 970 & 2097 with a common herbarium label, collected at different times from Nag-Konda forests, Chamba, N. W. Himalaya, of these *G. Watt* 2097 with field notes has been chosen here as lectotype of var. *susveolens*. This same plant was described as *V. kashmiriana* by W. Becker.

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Botanical Survey of India,
Howrah 711 103,
September 20, 1982.

S. P. BANERJEE
B. B. PRAMANIK

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38. DISTRIBUTIONAL NOTES ON *MARGARITARIA* L.F. (EUPHORBIACEAE) IN SOUTHERN INDIA AND SRI LANKA

Margaritaria L.f. is a relatively homogeneous genus of 14 closely related species (Webster 1979), spread all over the tropical world. It is characterized by dioecious habit, unspecialised branching pattern, tetramerous calyx, annular floral disc, papery endocarp and unique seeds (fleshy exotesta and thick, bony endotesta). It is allied to *Flueggea* (Dalzell 1852, Webster 1979) rather than to *Phyllanthus.* It differs from *Flueggea* in the lack of pistillode in the male flower and from *Phyllanthus* in having an annular disc substending the tetramerous androecium. Only two species of *Margaritaria* occur in India and Sri Lanka, namely *M. indica* (Dalz.) Airy-Shaw and *M. cyanosperma* (Gaertner) Airy-Shaw.

In earlier Indian Taxonomic Literature, *Margaritaria indica* has been included either under *Prosorus* Dalz. (1852) or *Phyllanthus* L. *s.l.* The genus *Margaritaria* L.f. (Suppl. Pl. 66. 1781) was revived by Webster (1957) who also revised it later in 1979. An attempt has been made here to review the present situation and the status of this genus in Southern India and Sri Lanka.

As a result, the species which occurs in India (i.e. *M. indica*) was found to have a wider distribution than what has been stated earlier (cf. Map 5 of Webster 1979). Some important collections of Thwaites (CP numbers) from Sri Lanka, including the *isotype* of *M. cyanosperma,* were located in MH, and what has been cited as *M. cyanosperma* (*Thwaites CP* 2155) by Webster (1979 :427) has been identified *M. indica.*

The two species of *Margaritaria,* which are found in Southern India and Sri Lanka, resemble each other in the glabrous nature of plant parts, leaf morphology, tricarpellary condition and in the rugose nature of endotesta (sclerotesta). However, they differ in the size of male flowers and in the number of female flowers per axil. Compared to *M. indica,* in fact in the whole genus (Webster 1979), the staminate flowers of *M. cyanosperma* are larger. Moreover, while 1-3 pistillate flowers occur in the axils of *M. indica,* they are solitary in *M. cyanosperma.*

1. **Margaritaria indica** (Dalz.) Airy-Shaw in Kew Bull. 20: 387. 1966, 25: 492. 1971, 26: 308. 1972 & 36: 330. 1981; Ramamoorthy in Saldanha & Nicolson, Fl. Hassan Dist. 345. 1976; Webster in J. Arnold Arb. 60: 425. 1979. *Prosorus indicus* Dalz. in Hooker's J. Bot. &

Kew Gard. Misc. 4: 346. 1852; Trimen, Hand. Fl. Ceylon 4: 27. 1898; Hook. f., Fl. Brit. India 5: 305. 1887; Gamble, Fl. Pres. Madras 2: 905. 1957 (repr. ed.). Type: India, Deccan, *Dalzell s. n.* (K, *n. v.*). *Phyllanthus indicus* (Dalz.) Muell.-Arg. in Linnaea 32: 52. 1863 et in DC. Prodr. 15(2): 417. 1866; Brandis, Ind. Trees 571. 1906; Airy-Shaw in Kew Bull. 16: 342. 1963. *P. stocksii* Muell.-Arg. in Linnaea 32: 151. 1863. Type: India, *Stocks & Law s. n.* (G, *n. v.*).

Specimens examined: INDIA. ANDHRA PRADESH: Chittoor Dist.: Mamandur (900 m): *G. V. Subbarao 31953*, 26-6-1969, ♀. A new record for the State. KARNATAKA: Coorg Dist. : Sampajee Ghat: *R. H. Beddome s.n.* MH. Acc. No. 46977, ♂. For additional citations *see* Ramamoorthy in Saldanha & Nicolson, Fl. Hassan Dist. 345. 1976 and Webster in J. Arnold Arb. 60: 426. 1979. KERALA: Idukki Dist: Mullakudy (850 m): *B. D. Sharma* 43862 14-3-1973, ♂; Malabar: *Stocks, Law L. C. s.n.*, ♂. ♀; Malabar (Wynaad): *R. H. Beddome s.n.* MH. Acc. No. 46976, ♂. ♀. TAMIL NADU : Coimbatore Dist.: Anamalais: *R. H. Beddome s.n.* Year 1866. ♂, ♀; Anamalais. Karianshola (762 m): *V. Narayanaswamy* 5365, 16-3-1931, ♂. Tirunelveli Dist. : Vasudevanallur R. F. (350 m) : *E. Vajravelu* 38853, 3-10-1971, ♀. SRI LANKA. No precise locality : *Thwaites CP* 2155, ♂ & ♀.

Distribution: INDIA. Western Ghats: Coorg, Kanara, Hassan, Wynaad, Anamalais, Thekkady and Tirunelveli. Eastern Ghats: Mamandur (Andhra Pradesh) in the south (present study) and Mahendragiri hills (Orissa) in the north (*ex* Haines, 1961). SRI LANKA.

2. **M. cyanosperma** (Gaertner) Airy-Shaw in Kew Bull. 20: 387. 1966; Webster in J. Arnold Arb. 60: 427. 1979. *Croton ? cyanospermus* Gaertner, Fruct. Semin. Pl. 2: 120. *pl.* 107. 1791. *Prosorus gaertneri* Thwaites in Hooker's J. Bot. & Kew Gard. Misc. 8: 272. 1856. *P. cyanospermus* (Gaertner) Thwaites, Enum. Pl. Zeyl. 281. 1861; Hook. f., Fl. Brit. India 5: 305. 1887; Trimen, Hand. Fl. Ceylon 4: 27. 1898. *Phyllanthus cyanospermus* (Gaertner) Muell.-Arg. in Linnaea 32: 51. 1863 et in DC. Prodr. 15(2): 416. 1866. Neotype: Ceylon, *Thwaites CP* 2601 (PDA, holotype, *n.v.;* designated by Webster, *l.c.* since Gaertner's type was considered to be missing). *Cicca gaertneriana* Baillon, Etud. Gén. Euphorb. 619. 1858. *Zygospermum zeylanicum* Thwaites ex Baillon, Etud. Gén. Euphorb. 620. *pl. 27. fig. 11.* 1858. Type: Ceylon.
Thwaites s.n. (P, *n.v.*).

Specimens examined: SRI LANKA. Without any precise locality: *Thwaites CP* 2601, ♀, (Isotype); No. Collector's name or locality: MH. Acc. No. 61815, ♂, ♀.

Distribution: Endemic to Sri Lanka.

Note: Webster (1979: 427) cited *Thwaites CP* 2155 (A) under *M. cyanosperma.* But the specimen available in MH (also *Thwaites CP* 2155) was found to be *M. indica.* It is interesting to note here that *CP* 2155 (PDA) was quoted under *Prosorus indica* by Thwaites (1856: 272) himself.

All the specimen cited in this paper are available in MH unless stated otherwise.

ACKNOWLEDGEMENTS

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February 5, 1983.

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39. *MELOCHIA PYRAMIDATA* LINN. (STERCULIACEAE) — A NEW RECORD FOR MAHARASHTRA

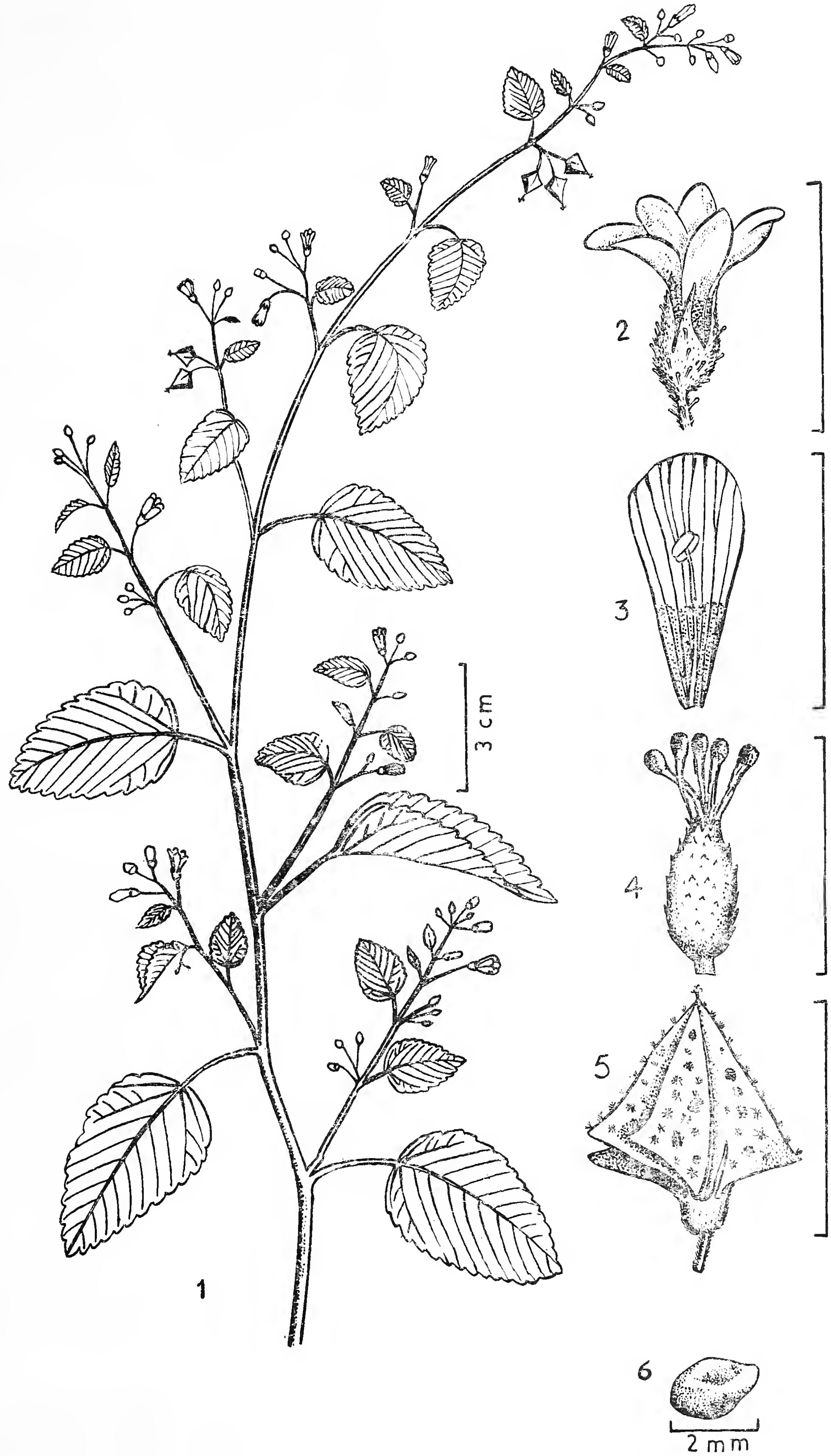
(*With six text-figures*)

Melochia pyramidata Linn. Sp. Pl. 674, 1753: Baker *et al.* in Flora of Java 1 : 406 1963 :M. T. Masters in Fl. Brit. India 1 : 374, 1874. S. S. Veppulari, Indian Forester, 95(5): 311-3, 1969.

An erect, profusely branched herb, 0.5-1.0 meter tall, Stem terete, woody at base. Leaves petiolate, stipulate, simple, alternate, ovate-lanceolate, 5.2-5.5 cm. long and 2.4-3.3 cm. broad, acute at the apex, obtuse at the base, crenate along margins, glabrous on both the surfaces. Veins 6-8, prominent on dorsal side, five veins given out from the base of the mid-rib. Petiole 2-2.5 cm. long grooved on dorsal side, with curved hairs on all over the groove, rusty. Stipules free lateral, deltoid, 0.5-1.0 cm. long and 0.2-0.3 cm. broad at the base, hairy on both margins, deciduous. Inflorescence leaf-opposed, umbel-like cymes, 4-6 flowered, peduncle 1.2-1.5 cm. long, pubescent, with glandular hairs all over; glands brown in colour. Flowers regular, bisexual, bracteate, purple in colour. Calyx 5-lobed, united at base, divided up to the middle, long-acuminate, green, glandular hairy. Corolla with 5 petals; purple, with yellow base. Stamens 5, opposite to the petals, adnate at the base; filaments 4-6 mm. long; anthers dorsifixed; pollen-grains spherical, smooth. Ovary superior, shortly stalked, oblong, hairy all over, 5-celled, syncarpous, with one ovule in each cell on axile placenta; style deeply 5-lobed, stout, hairy; stigma papillose. Fruit a capsule, broadly pyramidal, obtuse at base, longitudinally 5-winged; wings dilated towards base, 6-8 mm long, thin-walled, greenish-yellow, with red patches, stellately hairy, dehiscing longitudinally, Seeds dark-brown, roughly triangular.

Flowers: October-May.

This is an introduced Tropical American weed found in India, and recently located in Bombay in waste lands near Bandra and



Figs. 1-6. *Melochia pyramidata* Linn.
1. Flowering twig; 2. Single flower; 3. Petal with a stamen; 4. Pistil; 5. Fruit; 6. Seed.

Chembur. S. S. Veppulari reported it from Sibpur, Howrah. Masters (l.c.) records it as an introduced weed in India. However, he has not given any description or distribution. Since the first collection of this species from Bombay, it was kept under observation and repeated collections were made for its complete study. The identity of this species is confirmed by Mr. R. L. Mitra, Botanical Survey of India, Howrah, for which we are grateful to him.

Exsiceata: C. S. Lattoo — 6175 (Inst.), 6194 (BLAT).

BLATTER HERBARIUM,
ST. XAVIER'S COLLEGE,
BOMBAY-400 001.

S. M. ALMEIDA

INSTITUTE, OF SCIENCE,
BOMBAY-400 032,
January 14, 1983.

C. S. LATTOO

40. *ACRORUMOHRA DIFFRACTA* (BAKER) H. ITO (ASPIDIACEAE): A LITTLE KNOWN FERN FROM ARUNACHAL PRADESH AND SHAN STATE OF UPPER BURMA

In course of studying the Pteridophytic flora of Manipur and adjacent states I have come across a peculiar fern specimen (3 gatherings) with zig-zag rachis collected by Col. Baigui in 1874 from Duphla hills of Arunachal Pradesh, India and another by H. Collett from Luchin, Shan State of Upper Burma. Sheets of Col. Baigui were identified as *Lastrea undulata* Thw. and then determined as *Dryopteris obtussima* (Mett.) Christ. But on examination it has been determined as *Acrorumohra diffracta* (Baker) H. Ito based on the peculiarities stated by Ching (1934) as "This is a strikingly unique fern one should never forget once seen, on account of its lateral pinnae, particularly the lower ones, being peculiarly deflexed on the lower part of rachilets". Finally these specimens were also matched with the photograph of the Type specimen.

This plant is so far known from mainland, China, Indo-China and Taiwan but hitherto not reported from India. The plant was first described as *Nephrodium diffracta* Baker in 1898 based on the collection of A. Henry 1928 from Yunnan in 1898. Later there was confusion among several workers regarding its proper generic identity. Christ and C. Christinson transferred this under *Aspidium* and *Dryopteris* respectively. Later Ching placed it under *Rumohra* and it was treated by Hayata as a new species under *Dryopteris* as *D. reflexipinna* Hayata. Finally this plant has been correctly placed under the genus *Acrorumohra* H. Ito based on the characters (i) Zig-zag rachis with reflexed pinna, (ii) anadromaus veins, (iii) sori terminal on the veins and (iv) reniform to suborbicular indusium.

Moreover, Ching has mentioned that another species *Acrorumohra hasselttii* (Bl.) Ching also occurs in Assam which is based on G. Mann's collection.

However, not a single specimen of these two plants have been collected either

from Arunachal Pradesh or from Assam after Col. Baigui and G. Mann respectively.

The collection of H. Collett from Luchin, Shan states housed at Central National Herbarium (CAL) is also identified as *Acrorumohra diffracta* (Baker) H. Ito. It was not earlier reported from Burma. It is interesting to note that both Indian and Burma collections were made much earlier than A. Henry (1898) from China in 1874 and 1888 respectively. Thus it shows its distributional ranges from Taiwan, China mainland, Indo-China, Burma and North East India (Arunachal Pradesh).

For easy identification, the species is described below.

Acrorumohra diffracta (Baker) H. Ito in Nakai et Honda, Nov. Fl. Jap. 4. 104. 1939; Deval C. W. E. & Kuo, C. M. in Fl. Taiwan 1: 360. Pl. 127. 1975. *Nephrodium diffracta* Baker in Kew Bull. 1898: 230. 1898. *Aspidium diffractum* Christ in Bull. Herb. Bioss. 7: 17. 1899. *Dryopteris diffracta* C. Chr. in Ind. Fil. 262. 1905. *Dryopteris reflexipinna* Hayata in Ic. Pl. Form. 4: 174. Pl. 113. 1914; C. Chr. Ind. Fil. Suppl. 16. 1913-17; *Rumohra diffracta* (Baker) Ching in Sinensia. 5: 1. 69. Pl. 18. 1934.

Type: Yunnan, Mentze. *A. Henry* 9028, Description (Photo !)

Rhizome short erect to ascending densely clothed with dark brown, palcaceous scales, stipes brown, glabrous, 20-40 cm long; Lamina 25-40 cm long, 15-30 cm broad, quadripinnate, deltoid to broadly ovate; pinnae from rachis deflexed, more in first pair of the lower pinna, this gives the rachis a zig-zag form; rachis straminous, shiny, glabrous; pinnae 6-8 pairs, petiole reflexed, segments flabellate, undulate to crenate; pinnules chartaceous in texture, green even when dried; veins free 2-4 furked, nor raching to the margin; sori on the vein end; indusium persistent, reniformed with undulate margin.

Specimen Examined:

INDIA: Arunachal Pradesh, Duphla Hills, 2100 m. 1874, *Col. Baigui s. n.* (Acc. Nos. 16801, 16802, 16904 — CAL).

BURMA: Shan States, Luchin, 900 m, Feb. 1888, *H. Collett s. n.* (CAL).

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B. GHOSH

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HOWRAH-711 103,
December 21, 1982.

41. AN INTERPRETATION OF *BAUHINIA* L. (*SENSU LATO*) SPECIES ILLUSTRATED IN VAN RHEEDE'S HORTUS MALABARICUS (1678-1703)

The plates *Chovanna-mandaru* (Hort. Malab. 1: 58. t. 32. 1678), *Chovanna-mandaru* (Hort. Malab. 1 : 59. t. 33. 1678), *Veluttamandaru* (Hort. Malab. 1: 61. t. 34. 1678), *Canschena-pou* (Hort. Malab. 1: 63. t. 35. 1678), *Mandaru-valli* (Hort. Malab. 8: 55. t. 29. 1688), *Naga-mu-valli* (Hort. Malab. 8: 57. t. 30. 1688) and *Naga-mu-valli* (Hort. Malab. 8: 57. t. 31.

1688) in van Rheede's Hortus Malabaricus (1678-1703) are illustrations of plants belonging to the genus *Bauhinia* L. (*sensu lato*). In his bibliography to Rheede's Hortus Malabaricus (1678-1703), Dennstedt (1818) identified *Chovanna-mandaru* Rheede as *Bauhinia variegata* L., *Chovanna-mandaru* Rheede as *B. purpurea* L., *Velutta-mandaru* Rheede as *B. acuminata* L., *Canschena-pou* Rheede as *B. tomentosa* L., *Mandaru-valli* Rheede as (*Naga-valli* on plate) as *B. divaricata* L. and the plates *Naga-mu-valli* Rheede (as *Serpata-valli* on plate) as *B. scandens* L. The correct identity and up-to-date nomenclature of all the seven plates mentioned above are discussed here.

The word 'Mandaru' in Hortus Malabaricus (1678-1703) is derived from the local name 'Mandaram' in Malayalam, commonly used for the flowers of *B. purpurea.*

1. CHOVANNA-MANDARU Rheede, Hort. Malab. 1:57. t. 32. 1678.

Linnaeus (1753) referred Rheede's plate *Chovanna-mandaru* to *B. variegata* L. and also gave the locality of the species as Malabar. Hence there is little doubt as to the identity of this plate and Dennstedt (1818), Hamilton (1822) and Dylwin (1839) further confirmed this.

The name *Chovanna-mandaru* in the native language Malayalam refers to the red flowers of the plant. The flowers in this case are purplish-pink with the upper most petal darker and variegated with yellow stripes. Hamilton (1822), Roxburgh (1832) and de Wit (1956) considered *B. candida* Ait., a plant with white flowers, as a variety of *B. variegata,* namely *B. variegata* L. var. *alboflava* de Wit. The up-to-date nomenclature of the species is as follows.

Bauhinia variegata L. Sp. Pl. 375. 1753; Dennst. Schul. 10. 1818; Ham. in Trans. Linn. Soc. London 13: 497. 1822; DC. Prodr. 2: 514. 1825; Roxb. Fl. Ind. (ed. Carey) 2: 319. 1832; Wt. *et* Arn. Prodr. 296. 1834; Dylwin, Review Ref. Hort. Malab. 2. 1839; Baker in Hook. f. Fl. Brit. Ind. 2: 284. 1878; Prain in J. Asiat. Soc. Beng. 66(2): 505. 1897; de Wit in Reinwardtia 3: 411. 1956. — *B. variegata* (L.) Willd. sec. Roxb. Fl. Ind. (ed. Carey) 2: 319. 1832. — *Phanera variegata* (L.) Benth. in Miq. Pl. Jungh. 2 : 262. 1852. — *Bauhinia candida* Ait. Hort. Kew. 2: 49. 1789. — *B. variegata* var. *condida* (Ait.) Corner, Ways. Trees Mal. 383. 1940.

Type: L. 908. 112-142 (Neotype, duplicate of it i.e. Modhupore, Bogra, Bengal *R. E. P.* 12187 in BSIS !).

Distribution: Possibly a native of China cultivated in other countries including India and Malaysia.

2. CHOVANNA-MANDARU Rheede, Hort. Malab. 1 : 61. t. 34. 1678.

Rheede's plate *Chovanna-mandaru* is the only reference which Linnaeus (1753) gave under *B. purpurea* L. in Species Plantarum. Hamilton (1822) also interpreted the plate as *B. purpurea* and diagnosed the plant as differing from *B. variegata.* Because of the purple petals of this plant, Rheede (1678) named it *Chovanna-mandaru,* an appellation which he had already used for *B. variegata.* Authors like Dennstedt (1818), Roxburgh (1832) and Dylwin (1839) rightly identified *Chovanna-mandaru* as *B. purpurea* with the following nomenclature.

Bauhinia purpurea L. Sp. Pl. 375. 1753; Dennst. Schul. 10. 1818; Ham. in Trans. Linn. Soc. London 18: 497. 1822; Roxb. Fl. Ind. (ed. Carey) 2: 320. 1832; Wt. *et* Arn. Prodr. 296. 1834; Dylwin, Review Ref. Hort. Malab. 2. 1839; Baker in Hook. f. Fl. Brit. Ind. 2: 284. 1878; Prain in J. Asiat. Soc. Beng. 66(2): 180. 1897; de Wit in Reinwardtia 3: 406. 1956 — *B. coromandelina* DC. Prodr. 2: 515.

1825. — *B. triandra* Roxb. Fl. Ind. (ed. Carey) 2: 320. 1832. *Phanera purpurea* (L.) Benth. in Miq. Pl. Jungh. 1 : 262. 1852.

Type: *Merrill,* Sp. Blancoanae no. 1050 (L. 920. 278-111, Neotype).

Distribution: South-east Asia.

3. *Vellutta-mandaru* Rheede, Hort. Malab. 1: 61. t. 34. 1678.

Linnaeus (1753) in describing *B. acuminata* L. referred to Rheede's plate *Velutta-mandaru.* Subsequently Dennstedt (1818), Hamilton (1822) and Dylwin (1839) also identified the plate as *B. acuminata.* However De Candolle (1825) referred *Vellutta-mandaru* to *B. variegata* erroneously as the flowers of the former are white as against the red flowers in *B. variegata.* Similarly *B. candida* Ait. which is often treated as a synonym of *B. acuminata* also has purple-blotched or striped flowers. Eventhough Aitchinson's (1789) description is insufficient to distinguish *B. candida* from *B. acuminata,* the meaning of the name *Vellutta-mandaru* in Hortus Malabaricus is quite diagnostic, referring to its white flowers.

Bauhinia acuminata L. Sp. Pl. 375. 1753; Dennst. Schul. 17. 1818; Ham. in Trans. Linn. Soc. London 13: 497. 1822; DC. Prodr. 2: 513. 1825; Wt. *et* Arn. Prodr. 295. 1834; Dylwin, Review Ref. Hort. Malab. 3. 1839; Baker in Hook. f. Fl. Brit. Ind. 2: 276. 1878; Prain in J. Asiat. Soc. Beng. 59 (2): 244. 1890; ibid. 66 (2): 179. 1897; de Wit in Reinwardtia 3: 393. 1956. — *B. candida* Ait. *sensu* DC. Prodr. 2: 513. 1825.— *B. tomentosa* Naves in Blanco. Fl. Filip. J. Sci. (Bot.) 2: 433. 1907.

Type Herman, Ceylon Herb. 148 (BM).

Distribution. South-east Asia.

4. Canschena-pou Rheede, Hort. Malab. 1: 63, t. 35. 1678.

The plate shows a twig with flowers and fruits. Linnaeus (1753), Dennstdt (1818) and Dylwin (1839) identified it as *B. tomentosa* L. Hamilton (1822) eventhough considered *B. tomentosa* as 'the most improper appellation' for this species as the fully grown leaves are devoid of tomentum, also agreed to Linnaeus (1753) on the identity of the plate.

Bauhinia tomentosa L. Sp. Pl. 375. 1753; Dennst. Schul. 10. 1818; Ham. in Trans. Linn. Soc. London 13: 498. 1822; DC. Prodr. 2: 514. 1825; Roxb. Fl. Ind. 2: 323. 1832; Wt. *et* Arn. Prodr. 295. 1834; Dylwin, Review Ref. Hort. Malab. 3. 1839; Baker in Hook. f. Fl. Brit. Ind. 2: 275. 1878; Prain in J. Asiat. Soc. Beng. 66(2): 178. 1899; de Wit in Reinwardtia 3: 409. 1956 — *B. pubescens* DC. Mem. XIII Leg. 483. 1825.

Type: Cult. Bogor Botanic garden, I. B. 9a (Neotype : L. 950. 287-613).

Distribution. Indigenous to South-east Asia.

5. Mandaru-valli Rheede, Hort. Malab. 8: 55. t. 29. 1688 (*Nagavalli* vel *Mandaru-valli* on plate).

6. Naga-mu-valli Rheede, Hort. Malab. 8: 57. t. 30, 31. 1689 (*Serpata-valli* on plate).

Rheede's plates *Mandaru-valli* and *Naga-mu-valli* are the figures of one and the same plant in two different stages of growth. Dennstedt (1818) identified both *Mandaru-valli* and *Naga-mu-valli* as *B. divaricata* L. which is now known as a monandrous South American species (de Wit 1956) not recorded from Old World. Prior to Dennstedt (1818), Linnaeus (1753) quoted *Mandaru-valli* when he described *B. scandens* L. and from the note he had given under *B. scandens* in Species Plantarum, it is clear that *Naga-mu-valli* was the plant which he intended as typical of the species. Further, Linnaeus (1754) in Stickman's Herbarium Amboinense also identified *Folium linguae* Rumph. (Herb. Amb. 5: 1. Pl. 1. 1747) with *B. scandens* L. Pointing out this as a mistake, Merrill (1917) identified *Folium linguae* Rumph. with *B. lingua* DC. (*Phanera*

lingua (DC.) Miq.). Because of this confusion, the name *B. anguina* Roxb. was often used for the plant under discussion eventhough it was a later synonym of *B. scandens* L.

In giving the nomenclature of the species under *Bauhinia*, the concept of Taubert (1894) and Hutchinson (1964) is accepted here as against that of de Wit (1956) who recognised *Lasiobema* (Korth.) Miq. as a distinct genus with *L. scandens* (L.) de Wit (*B. scandens* L.) as the type species.

Bauhinia scandens L. Sp. Pl. 374. 1753; Dennst. Schul. 13. 1818; Roxb. Fl. Ind. (ed. Carey) 2: 326. 1832; Dylwin, Review Ref., Hort. Malab. 39. 1839; Prain in J. Asiat. Soc. Beng. 66(2): 94. 1897 — *Phanera scandens* (L.) Rafin Sylv. tell. 122. 1838 — *Bauhinia anguina* Roxb. Hort. Beng. 31. 1814 (*nom. nud.*); Pl. Corom. 3: 82. pl. 285. 1819 & Fl. Ind. (ed. Carey) 2 : 328. 1832; DC. Prodr. 2: 516. 1825; Wt. *et* Arn. Prodr. 298. 1834; Baker in Hook. f. Fl. Brit. Ind. 2. 284. 1878. — *Lasiobema anguinum* (Roxb.) Korth. *ex* Miq. Fl. Ind. Bat. 1(1): 71. 1855 — *L. horsfieldii* Miq. Fl. Ind. Bat. 1(1): 71. 1855. — *B. horsfieldii* (Miq.) Macbride, Contr. Gray Herb. II no. 59: 23. 1919. — *Lasiobema scandens* (L.) de Wit, Reinwardtia 3: 427. 1956.

Type: *Horsfield* s.n. (L. 169). Java (Holotype, K).

Distribution: India, Indo-China and possibly Sri Lanka.

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K. K. N. NAIR[1]

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NOTES AND NEWS

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A CONTRIBUTION TO THE BIOLOGY OF HOUBARA: 1982-83 WINTERING POPULATION IN BALUCHISTAN[1]

Afsar Mian[2]

(*With a text-figure*)

The Houbara Bustard (*Chlamydotis undulata macqueeni*) is very widely distributed in the valleys and semi-desert plains of Baluchistan, depending upon the distribution of the plants. They are winter visitors and stay in the area from October to February, each year, though some of the northern areas may harbour a reasonable population till early April. The bird is under severe hunting stress from the local hunters (approximately 1500 birds) and the visiting Arab falconers (claiming at least 2860 birds) in all the areas bearing a sizeable wintering population. A tentative population distribution map has been attempted to show the relative frequencies of the bird in different areas of the province. There are indications that some 50 — 100 pairs do breed in Western Baluchistan, but this activity does not seem to be a regular feature of the area.

Introduction

Our preliminary research on the biology and conservation of the Houbara Bustard (*Chlamydotis undulata macqueeni*) with special reference to its wintering population of Western Baluchistan, during 1981-1982, prompted us to continue our research activities on this elegant bird with the aim of providing sufficient research data upon which a scientific conservation strategy could be based, before it is completely lost from this part of the globe (Mian & Surahio 1983, Mian & Shaheena *in press*; Mian 1983). This paper therefore presents some further data regarding the distribution, population levels, and hunting stress regarding the population of the bird wintering in Baluchistan and adjoining areas during 1982-83.

Methods and Materials

Regrettably, severe budgetary limitations prevented us from conducting an extensive tour of the area, as we had hoped, to

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collect first hand information, on this bird. However, to overcome this serious handicap a carefully drafted questionnaire was circulated to some of our past students residing in Panjgur (29.98° N and 64.10° E) and Sibi (29.56°N and 67.89°E), to the Sub-divisional Officer, Wildlife, of the Baluchistan Forest Department, who accompanied the visiting Arab falconers in Chagai (26.98°N and 64.70°E) and Kharan (28.58°N and 65.42°E) areas and to a well-reputed old hunter of Taunsa (30.30°N and 70.65°E). The questionnaire contained the appropriate questions regarding the preferred habitat, approximate density of the bird in favourable areas, preferred food, migration patterns and dates, hunting pressures in that locality and the chances of breeding in the area. The facsimile of the questionnaire is shown in appendix I. All were instructed to collect information through their own observations and through contacts with other reputed hunters and local people of the area. These informers were then further cross questioned by us personally in March 1983, so as to extract as much information as possible and to be able to evaluate the possibility of a bias, which might have crept into their observations.

Some 16 students, who had just returned from their long winter break (December 17, 1982 to February 28, 1983) from different areas of Baluchistan, were also interviewed the different questions of our basic questionnaire or anything they might have noticed concerning the biology and ecology of the Houbara in their respective areas. Surprisingly, the information collected through various independent sources bore a remarkable identity with one another. A few observations, which were contrary to the general consensus of views were eliminated from the final analysis, after giving due consideration to the status of the source.

Sokal & Rohlf (1969) were followed for the statistical analysis of the data.

Results and Discussion

Houbara Behaviour and Habitat Preference. The majority of the information collected by different sources regarding the behaviour and habitat preference of the Houbara Bustard are in conformity with what we reported in our earlier study (Mian & Surahio 1983). The Houbara, in general is a very wary bird intolerant of human disturbance and hence prefers flat desolate desert plains having sandy or loose stony substratum with sparsely distributed bushes, so that its vision is not restricted. The bird inhabits the open, vast steppic desert plains avoiding the narrow valleys and mountain slopes. It is said to avoid the very extreme desert conditions in this region, where it shows a very sparse distribution, especially during certain years of better precipitation, though it is found in almost similar inhospitable conditions in other parts, i.e. Cholistan (Mirza 1971). The houbara also avoids the large human settlements, though the small scattered villages and nomadic shepherd camps as well as the grazing livestock, i.e. sheep, goat, cattle and camel have little influence over its distribution.

The Houbara is mainly diurnal in habit, though it is also active during moonlit nights. It rests during the hot part of the day in ditches or shallow dry courses of the hill torrents and on certain flat beds during dark night. The Houbara is generally regarded as omnivorous and hence may feed on almost everything available to it, including dried grasses, associated insects and even reptiles, but predominantly it is a herbivore and largely depends upon vegetable

matter such as leaves, shoots and seeds of the preferred plants. Some observers believe that it prefers moonlit nights for feeding activities, but it mainly feeds during the day in accordance with the available conditions. The presence of very large eyes in the bird lends some support to the contention that it is partly nocturnal in feeding activity.

Migration. The majority of the observations collected through our questionnaire regarding the migration of bustards confirm our previous report (Mian & Surahio 1983) that the wintering population of the Houbara migrates into Baluchistan through very diffused routes all along the north-western border of the province, and it disperses southwards and eastwards gradually in the various parts of Baluchistan. The size of the incoming groups is larger in the northern areas like Chagai plains, Dasht plains near Nushki, and the plains of Yakmuch (10-12 birds per group) as compared with the number observed further south in Panjgur and in Sibi (2-4 birds per group). The larger groups can also be observed in southern and eastern regions during the later part of the immigration season. The population passing through Taunsa also have a smaller size of the group compared with that observed in Chagai and Nushki. This may be because the population reaching Taunsa has travelled a longer route, and has consequently undergone considerable dispersion prior to reaching the area. The population of Taunsa, however, further migrates into deserts of Thal and Cholistan, of the Punjab. The observations collected by us also indicate that the wintering population of Sibi and deeper parts of Sind, mainly come through Baluchistan and hence confirm the findings of Surahio (1981, 1982).

The precise dates, when the bustards were first seen in the different areas could not be recorded. However, the information conveyed to us from the different parts of the province and adjoining areas suggests that the birds are first noted in Baluchistan in late September or in the first week of October in the deeper parts, and they start migrating back to their summering grounds during late February and early March. However, a sizeable population of the bird is present in plains of Yakmuch, Chagai and Kharan till late March or early April. The duration of stay along their migratory routes and their various wintering grounds depends upon the relative abundance of food and suitable vegetation. It has also been frequently observed that the birds returning through an area on spring migration use the same routes as were adopted while entering an area in autumn.

Our questionnaire revealed consistent observations that the Houbara migrates on moonlit nights. It could not be ascertained as to whether this was a preferred habit or if this was an occasional preference. This also does not completely rule out the possibility that there is no migration during dark nights, because there can be few casual observations at that time and also the activities of the hunters (who might observe the bird) are generally limited during dark nights. This would suggest that a further detailed study is needed regarding this aspect of the Houbara biology. If these observations prove to be true, then the time of migration will also need to be adjusted to the lunar cycle and a variation is to be expected between years.

It was also interesting to note that an individual bird with a partially damaged tarsus was regularly observed visiting the same area of Sibi for four consecutive years. This information seems to be in conformity with similar reports on other non-related migratory birds including small passerines, which suggest a

faithful adherence to certain predefined routes and localities, during migration. Further colour banding studies on the Houbara would be particularly interesting to corroborate such observations.

Hunting. The observations conveyed to us by different informants revealed that the Houbara is hunted in the different areas by the local populace (using shot guns) for pleasure and also to obtain meat. The hunting is sometimes facilitated by the use of a jeep or by approaching the bird at a reasonable shooting distance through a herd of grazing sheep/goat/cattle/camel or by riding camel back or on a bullock cart. Netting of the live bird is also practised, on a limited scale, in all areas having a sizeable population of the Houbara. A triangular enclosure of nets is used in western Baluchistan, whereas in Taunsa and Sibi areas straight nets are used in which apparently the foot of the bird gets caught. The bustards are driven into the net with the help of a herd of camels or other livestock, bullock carts and jeeps.

A comprehensive report regarding the hunting activities of local hunters is not available. The reports from Taunsa suggest that some 300 birds were killed during the last winter. This is despite the fact that the Houbara is a partially protected species under the Punjab Wildlife Protection Ordinance under Schedule III. Various reports regarding the bags of the local hunters, when collected together lead us to calculate that a total of some 1500 bird were killed in western Baluchistan, Sibi and adjoining areas of Taunsa by such local *shikaris.* It is said that the hunting toll by the local hunters is on the increase due to a gradual sophistication of the hunting methods and hunting aids including motorised communication and the development of link roads. Further, the number of birds killed was relatively higher during this winter (1982-83) due to a greater population of the Houbara present in all the areas, as a result of favourable rains the previous winter.

The major hunting stress undoubtedly is from the visiting falconers, coming from the Middle East and the Persian Gulf States. The available data suggest that a minimum of 1742 birds were killed by such visiting hunters over a period of 28 days, in Chagai District alone. In Kharan, two independent parties hunted at least 768 birds in 41 days. The report from Sibi and Taunsa indicated that between 250-350 birds were killed by the visiting Arab falconers. Thus, the cumulative bag data for all the visiting hunters throughout Baluchistan and adjoining areas suggest that some 2860 birds have been hunted during this winter. It seems relevant to mention that because of the secrecy being maintained by these visiting foreign dignitaries and the security measures being adopted in such areas very exact bag data are difficult to collect. In fact, informers consistently expressed the opinion that the actual numbers hunted were much more than reported.

There is unfortunately ample evidence of a progressive increase in the hunting activities of the visiting falconers. The western areas of Baluchistan were visited by only one party during 1981-82, whereas at least three parties visited the area during 1982-83. The available reports regarding the hunting success of these foreign hunters are also alarming. Whereas a total of 418 birds were hunted during 1981-82 in Chagai and Kharan districts, some 2510 birds have been hunted during 1982-83, in the same area. It is true that the size of the hunting bag has increased during the last winter due to a comparatively higher population of the bustards wintering in this region, but the higher number of hunting bags of the Houbara

has also been possible due to the gradual acclimatization of the visiting Arab falconers and their increased local knowledge of the area. There is an urgent necessity to evaluate the long term effect of such a large scale hunting stress on the population of the Houbara in the area.

The available hunting bag data of the visiting falconers reveals that there were more females hunted than males (in Chagai 820 males: 922 females, $\chi^2 = 5.972$, significant at 0.02 level; in Kharan 131 males: 177 females, $\chi^2 = 6.870$, significant at 0.01 level; and 138 males: 322 females, $\chi^2 = 73.6$, very significant). This is despite the fact that the female Houbara gives a much tougher fight to the falcon than the males (personal communication from an experienced local hunter of Yakmuch, District Chagai). It is believed that though there are very slender chances of survival of the male bustard from the falcon attack, the female stands certain chances of surviving such an attack. Further, the males are almost 25% larger than the females and hence have more chances of being spotted by a falconer. These facts when seen together suggest that the number of females are more in population than males. If further studies prove this hypothesis to be true the causes for such a population imbalance would be very interesting to study. The alternative hypothesis would be that the population has an equal number of males and females; but certain sexual differences and behavioural adaptations render the males less vulnerable to falcon hunting. This would mean that a larger proportion of the females are being hunted, which would certainly have a very detrimental effect upon the population of the Houbara.

The analysis of the daily bag of the parties hunting in the same area for many consecutive days reveal that hunting for 9 consecutive days by 104 falcons with the help of 15 vehicles in Harmagai (Kharan) and by 108 falcons with the help of 37 vehicles in Pul-Chotao (Chagai) did not cause of significant decrease in the number of the hunted birds (Regression coefficient = 1.5833, $t_{(7)} = 0.2491$, P = 0.90 — 0.80, highly non significant; and, Regression coefficient = 2.1833, $t_{(7)} = 1.9188$, P = 0.10 — 0.05, not significant, for Chul-Chotao and Harmagai, respectively). However, hunting for 10 consecutive days by 108 falcons and 37 vehicles in Yakmuch (Chagai) and for 17 consecutive days by 98 falcons with the help of 15 vehicles in Charkohan (Kharan) did cause a decline in the size of the hunting bag (Regression coefficient = — 0.326, $t_{(8)} = 15.3234$, P = 0.001, very highly significant; and, Regression coefficient = 0.326, $t_{(15)} = 4.6317$, P = 0.001, highly significant). However, on the last day of the hunt in Yakmuch only 15 Houbara could be captured as compared to some 90 captured on the first day; but when the same party visited the same area after an interval of 16 days, the original high hunting bag was once again maintained indicating that the population during the later hunting period comprised of newly arrived migrant birds. These facts would suggest that the population is either very mobile and is constantly shifting or that there is a continuous replacement of the population in the area by that present in the surrounding areas. The second alternative seems to be more true as the Houbara is said to travel long distances in search of food or unexploited habitat (Surahio 1981). Under such conditions it seems that in the future years the population of the Houbara will be subjected to a greater hunting stress, as the visiting hunters become more familiar with the area and the hunting aids get more sophisticated.

Population Distribution: The Houbara seems to have a wide distribution in Baluchistan and its adjacent areas. The high densities of the bird are thus present in vast, open and desert steppes of Yakmuch, Nushki and surrounding areas of Chagai, the plains of Kharan and Punjgur, the coastal areas of Mekran, Dasht area of Mustung, plains of Sibi and adjoining parts of Sind, and in Taunsa. The population of Taunsa, however, moves to the riverian area during dry season. The Houbara, generally avoids high mountain ranges and narrow valleys even when passing to their wintering or breeding grounds. Thus the Houbara is almost non-existent in the northern hilly tract of Baluchistan such as the Sulaiman Range, the Toba Kakar Range and the northern extremities of the Central Brahui Range, occupying most of the Loralai, Zhob, Pishin and Quetta districts. They are found in very limited numbers in Khuzdar and Kalat. The extreme desert conditions existing in areas beyond Nok Kundi and Hamun-i-Mashkhel also pose limitations to the dispersal of the Houbara population, though they are present in small numbers in a very dispersed way during certain seasons having better rainfall.

The hunting success of the Arab falconers may prove to be a valuable index of the population density of the Houbara in the area. Because of their very ample monetary resources hunting is concentrated wherever the quarry is most abundant irrespective of the accessibility or logistic problems in reaching remote areas. Their only consideration being to reach the area that has a high population of the bird, which could fetch them greater hunting pleasure. In order to achieve this objective, these falconers have advance survey parties, and employ local guides and hunters, to aid

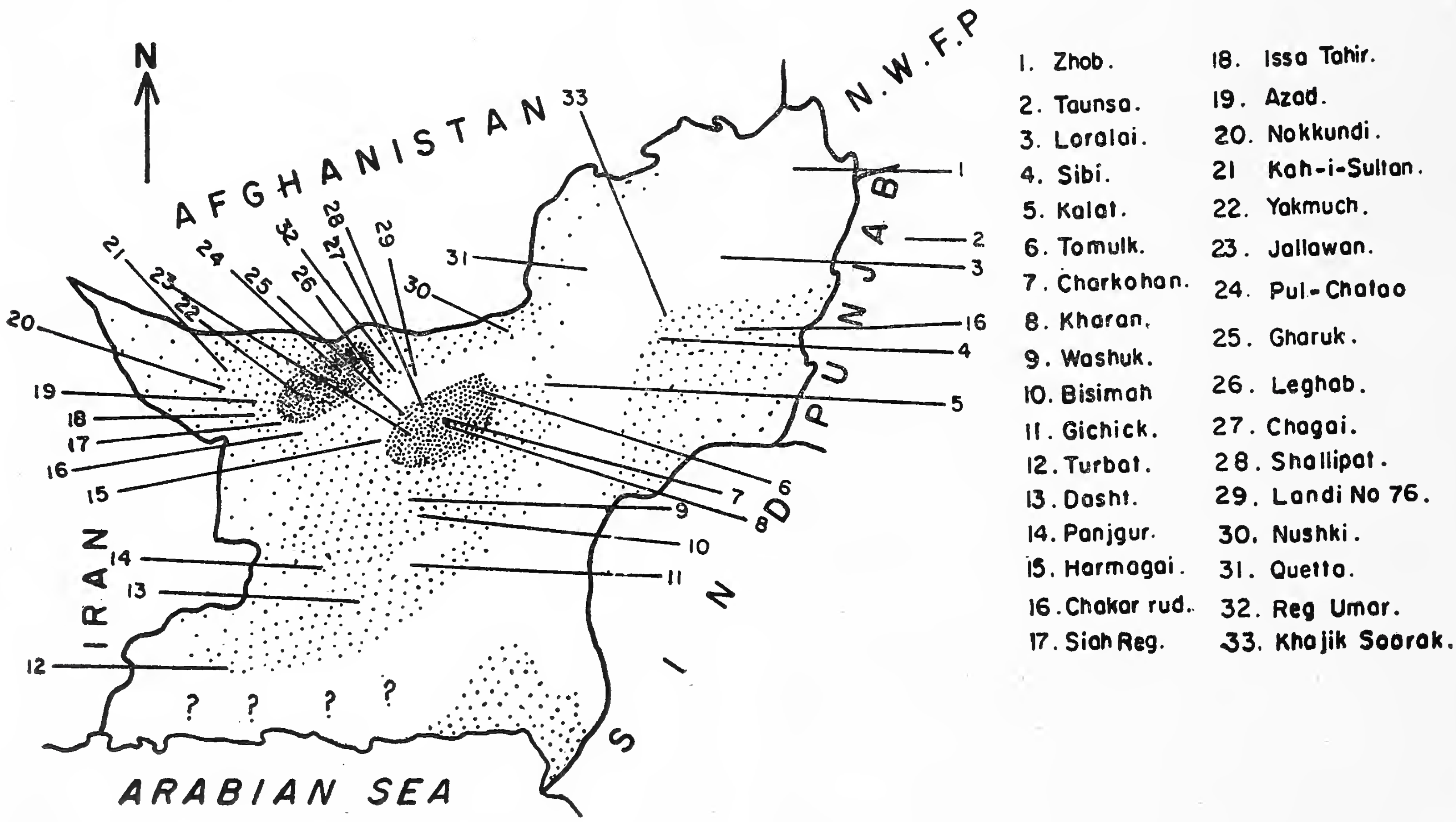

Fig. 1. A line sketch of the Baluchistan showing the tentative distribution of the wintering population of Houbara Bustard.

them in selecting better camping areas. The survey is conducted by these advance survey parties, so as to find the areas of high bustard population density. The recent evidences suggest that higher bustard population existed in Yakmuch and Pul-Chotao areas of Chagai, and Hurmugai and Charkuhan areas of Kharan. High densities of the bird are present in Laghab, Rag Umar, Azad, Issa Tahir, Siah Reg and Landi No. 76 in Chagai District; Shelli Pat, Barkoh, Shamshi, Washuk and Besimah in Kharan, Gikch, Taroom and Dast in Panjgur; Mach Chakar Khan, Safie, Kalay Wala Kirar, Washin in Sibi. Adequate population is present in Dasht area of Mustung, Khuzdar, Kalat and Taunsa. A proper scientific study and survey of the areas is still very urgently needed to evaluate the actual population levels in different areas, however, a tentative map showing the population density according to the hunting successes can be derived from these observations and is presented in Figure 1.

There is a general consensus of opinion that there was a much larger population of the Houbara in all its wintering grounds, in Baluchistan during both 1981-82 and even greater population during 1982-83 winter season. This may be attributed to the fact that the winter rains were high during 1981-82, resulting in a more luxuriant vegetation in the area. Further data are needed to study such annual fluctuation in the population of the visiting bird. These casual observations of the hunters and local people may not be the indicator of the fact that the visiting population was significantly higher than the previous year's, but the local presence of rich vegetation cover in those areas which received the excessive rainfall might have prevented the normal dispersion of the population of the bird. However, such conditions definietly aid the activities of the hunters, leading them to jump to the erroneous conclusion regarding the population level. If this alternate hypothesis is true then the better rainfall and vegetation may have a deleterious effects upon the population rather than bolstering it up. In fact the winter rains in the area show a cyclic variation of 4-5 years (Roberts 1973). Future data regarding such population fluctuations and hunting successes would be interesting.

Breeding: It has been frequently speculated that the vast desolate areas of Baluchistan may harbour some breeding activities of the Houbara (Ali and Ripley 1969, Siddique 1972, Anonymous 1972), however, concrete evidence is lacking. Anonymous (1972) did report collecting some Houbara eggs from Muslakh Forest Reserve (District Pishin) and these eggs were hatched in the Government Poultry Farm, Quetta; but the chicks did not survive. During our previous survey of potential breeding areas in Chagai and Kharan in April, 1982, local hunters and Forest Guards did report about the occurence of the breeding activity of the bird in the area and promised to show some nests with eggs. However, because we failed to find any direct evidence about the presence of eggs, young chicks or even adult birds in that season, we considered the probability of any Houbara breeding in that area to be very slight (Mian & Surahio 1983). However, we continued our efforts to collect further data regarding this important aspect of the biology of Houbara Bustard. It was brought to our notice that Sheikh Mohammad Bin Rashid Al-Maktoum of Dubai had hatched a Houbara chick from a clutch of three eggs most probably collected in Baluchistan (W. A. Kermani 1982).

The information collected by us so far indicates that there has never been any signs of the breeding activity in the eastern flank of

Baluchistan, i.e., Sibi and Dera Ghazi Khan, and that eggs or young chicks have never been reported from that region till now. However, reports regarding Chagai, Yakmuch, Kharan and Punjgur seem to indicate that occasional breeding in these areas does occur. The description of the eggs, and the nest described by various sources from these areas agree perfectly with those reported in the literature (Collar 1979). Though the exact data regarding the number of the breeding pairs present in the area is not available, it is believed that some 50-100 pairs lay eggs in Yakmuch, Kharan and the valley of Chagai Hills. There are reports of some very limited breeding activity of the bird in the vicinity of Punjgur. Further research is needed to confirm how far these reports are reliable, but it is suspected that this breeding activity is not a regular but only sporadic feature of the area by straggling birds. Furthermore, these birds are reported to fly off to their normal summering grounds, when the chicks are still very young. If such is the case further research would still be needed to ascertain the factors which induce occasional pairs to lay eggs in the area and then continue with their northward migration leaving the very young chicks behind.

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Appendix I

Facsimile of the questionnaire regarding biology and breeding research on the Houbara Bustard in Baluchistan.

N.B. Please collect the information by your own observations and through contact with the reputed local hunters of the area.

1. At what approximate time the first incoming bird was seen in the area.
2. What hour of the day is prefered for migration.
3. What are the approximate number of the birds in an incoming group.
4. From which direction these birds enter the area.
5. What is the approximate period of stay of the bird in the area.
6. What is the preferred habitat of the bird in the area.
7. Describe the topography and general vegetation of the area.
8. What is the preferred food and how abundant is it in the area.
9. What are the areas having high/medium/low densities of the bird.
10. What is the approximate number of the birds in the area.
11. What is the general mode of hunting of the local and foreign hunters in the area.
12. What is the customary practice of live trapping of Houbara in the area.
13. Give a reasonable estimate regarding the number of the birds hunted by local hunters in the area. Please indicate sex and age, if possible.
14. What is your information regarding the number of the foreign hunting parties, number of hunters in each party, number of falcons and vehicle. Can you give the number of the birds hunted by the said party with dates and sex of the hunted bird.
15. Have you seen any eggs/young chicks/brooding birds in the area. If yes, what was the shape, size and number of the eggs per nest.
16. What are the approximate breeding pairs present in the area.
17. Have you seen the bird during summer, i.e., April to September.
18. What is the approximate season of the egg laying.
19. What is the approximate time, when the birds leave the area.
20. What is the number of birds in a group leaving the area.
21. Any other information.

If possible please collect the stomach of the hunted birds, preserve it in formalin/alcohol, bag these separately in plastic (cellophene) bag with a wing primary feather and tarsus. Please record the time and date of the capture of the bird.

ORIENTAL LYCAENIDAE, RIODINIDAE, AND HESPERIIDAE FROM THE CENTRAL NEPAL HIMALAYAS[1]

Oakley Shields[2]

A total of 8 lycaenid, 2 riodinid, and 6 hesperiid species are reported from the Oriental realm of the Kali Gandaki of Nepal, along with information about their known ranges, elevations, and food-plants. The food-plant of *Lycaena pavana* is *Polygonum recumbens* (Polygonaceae). The lack of any hesperiid above about 2300 m in this region is noted.

Introduction

The following is an account of the Lycaenidae, Riodinidae, and Hesperiidae I collected mostly in August in the Oriental realm of the Kali Gandaki region of the Central Nepal Himalayas. These were taken incidentally to the International Nepal Himalayan Expedition for Lepidoptera Palaearctica (INHELP) 1977 expedition's main objective of high elevation Palaearctic butterflies, reported elsewhere (Epstein 1979a, b; Shields 1981).

Lycaenidae

1. **Celastrina huegelii oreana** Swinhoe

   Ca. 24-32 km SW Marpha, Kali Gandaki Valley, est. 2530-2560 m, VIII-8-77, 17♂♂ 1♀ fresh to worn, mostly at mud.

   Kalopani, 32 km SW Marpha, 2530 m, VIII-9-77, 1♂ 13♀♀ fair to worn.

   Between Kalopani and Lethe, 2530 m, VIII-9-77, 13♂♂ 5♀♀.

   Between Kalopani (2440 m) and Ghasa 2010 m), VIII-10-77, 4.

2560 m was the height in elevation. The subspecies occurs in Sikkim, Bhutan, Assam, and Nepal (Cantlie 1963).

2. **Celastrina dilectus dilectus** Moore

   6½ km W Khangsar, upper end (N side) Khangsar Valley, 4500 m, VII-9-77, 1♂ fair.

This was undoubtedly a stray from lower, subtropical elevations. It ranges in Simla-Karens, and Nepal (Cantlie 1963). The species is distributed from NW Himalaya through Burma to W China and Formosa, and also occurs in Malaya (Shirozu & Saigussa 1962).

3. **Celastrina carna marata** Corbet

   Vicinity of Lumle, 1615 m, VIII-15-77, 1♂ 1♀ fresh.

C. carna occurs in India to Malaya, Java, and Sumatra (Corbet & Pendlebury 1956).

4. **Zizeeria maha maha** Kollar

   Between Kalopani (2440 m) and Ghasa 2010 m), VIII-10-77, 6.

   Ghasa (2010 m) to Tatopani (1220 m), VIII-11-77, 5.

According to Shirozu & Saigusa (1962, 1963), this common species is distributed from Baluchistan and Kashmir to India, Assam, Siam, S. China, S. Korea, Japan, Formosa, and the Ryukyus. *Z. maha maha* itself occurs in Baluchistan, Kurram, Pakistan-Central, N

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India-Nepal, Sikkim, Assam, and Burma (Cantlie 1963). An unspecified subspecies of *Z. maha* flies from 1220-2440 m in SE Tibet (Evans 1915). Shirozu (1955) and Fujioka (1970) list many Nepal records. Its food plant is *Oxalis corniculata* (Oxalidaceae) (Sevastopulo 1973).

5. **Jamides celeno celeno** Cramer, warm-season form.
   Between Naudanda (1458 m) and Pokhara (914 m), VIII-16-77, 1♂.

This species is common in India, Sri Lanka and Burma, up to 1980 m in S India (Wynter-Blyth 1957). Shirozu (1955), Forster (1961), and Fujioka (1970) list some Nepal records. *J. celeno* is distributed from Ceylon and India to Formosa and South China, and through the Archipelago to New Guinea and the Bismarcks (Corbet & Pendlebury 1956). *Heynea* (Meliaceae) and *Butea* (Leguminosae) are the food plants (Sevastopulo 1973).

6. **Lycaena pavana** Horsfield & Moore
   Between Kalopani and Lethe (2530 m), VIII-9-77, 2♂♂ 2♀♀ fresh, generally on yellow *Aster*, yellow *Potentilla*, etc., flying in same area as several *L. phlaeas*.
   Between Kalopani (2440 m) and Ghasa (2010 m), VIII-10-77, 37♂♂ 13♀♀ mostly fresh, sometimes worn, primarily at flowers along streams. Just NE of Ghasa (est. 2100 m), one female oviposited at mid morning on the vegetative sprig of the moist-area plant *Polygonum recumbens* Royle ex Bab. (det. by A. O. Chater, BMNH).

2530 m was the highest elevation at which we found this species. *L. pavana* occurs from Kashmir to Kumaon and Nepal (Cantlie 1963), and is fairly common to local. In Kumaon it is known from 1370-3960 m (Nicéville 1890). It flies from June to August.

7. **Heliophorus androcles coruscans** Moore
   Between Kalopani and Lethe (2530 m), VIII-9-77, 1♀ worn.
   Between Kalopani (2440 m) and Ghasa (2010 m), VIII-10-77, 16.
   Between Tatopani (1220 m) and Chitre (2150 m), VIII-12-77, 3.

H. a. coruscans occurs from Kashmir to Kumaon and Nepal. The species is found from Kashmir to Assam, SE Tibet, and N Burma, with four subspecies; not rare (Wynter-Blyth 1957). Shirozu (1955) records *coruscans* from west, north, and east Nepal. Champion & Riley (1926) report *coruscans* at 3660 m in the Gori Gorge. Fujioka (1970) gives a number of records for *coruscans* from the NE corner of Nepal, for July and August.

8. **Heliophorus epicles indicus** Fruhstorfer
   Vicinity of Birethanti, 1005 m, VIII-14-77, 2.

There are seven named subspecies of *epicles,* extending from Kumaon to Assam, Burma, the Oriental region, Formosa, and Java and Sumatra (Shirozu & Saigusa 1962). *H. e. indicus* occurs in Nepal, Sikkim, Bhutan, Assam, and Annam (Shirozu 1955). There are records from Katmandu and East Nepal (Shirozu 1955, Fujioka 1970).

Riodinidae

1. **Zemeros flegyas indicus** Fruhstorfer, wet-season form. Tatopani (1220 m) to Chitre 2150 m), VIII-12-77, 1♂. Lumle, 1615 m, VIII-15-77, 1♂.

This species ranges from Mussoorie to Assam, Sumatra, Nias, Java, Bali, Borneo, Lombok, Sumbawa, Sumba, Hainan, Siam, Tenasserim, Shan-States, Mergui, Burma, South China, Philippines, Malaya, and Celebes, where it is common. See Shirozu (1955), Forster (1961), and Fujioka (1970) for Nepal records. It is separated into 12 subspecies.

2. **Dodona ouida ouida** Moore
Tatopani (1220 m) to Chitre (2150 m), VIII-12-77, 1♂.

The species occurs in the Himalayas as far west as Mussoorie; hills of NE India, Burma, from 1220-2440 m, to West China (Wynter-Blyth 1957). It is also known from Lower Tsang Po, 2135 m, SE Tibet (Evans 1915). See Shirozu (1955) and Fujioka (1970) for Nepal records. Typical *D. ouida ouida* occurs from Nepal to Burma. Both these riodinid species use *Maesa* (Myrsinaceae) as a food plant (Sevastopulo 1973).

Hesperiidae

1. **Coladenia dan fatih** Kollar
Tatopani (1220 m) to Chitre (2150 m), VIII-12-77, 1♂ fresh. Lumle, 1615 m, VIII-15-77, 1♂ fresh.

It is found in the NW Himalayas (Kangra to Nepal), Sikkim to Burma, NW Siam, Indo-China, and Hainan (Evans 1949, Shirozu & Saigusa 1962). Ssp. *faith* continues in a slightly modified form into the E Himalayas. *C. dan's* foodplant is *Achyranthes aspera* (Amaranthaceae) (Sevastopulo 1973). This species has 11 subspecies, distributed from NW Himalayas to Yunnan, Indo-China, Malay Peninsula, Borneo, Celebes, and Greater and Lesser Sunda Islands (Shirozu & Saigusa 1962).

2. **Spialia galba** Fabricius
Lumle, 1615 m, VIII-15-77, 1♂ fresh.

It ranges from Sri Lanka, S India, Cutch, Sind, Ganjam, central India, NW Himalayas (Kashmir-Kumaon), Bengal, Sikkim, Assam, Burma to S. Shan States, to South China and Hainan (Evans 1949, Shirozu 1955). This is the only representative of this Palaearctic genus in the Oriental region. The foodplant is *Sida rhombifolia* (Malvaceae) (Sevastopulo 1973).

3. **Bibasis vasutana** Moore
Birethanti, 1005 m, VIII-14-77, 1♂ fresh.

Found in Nepal, Sikkim, Assam, and Burma (Karens, Dawnas) (Evans 1949).

4. **Aeromachus stigmata stigmata** Moore, dry season form. Kalopani to Ghasa, 2440-2010 m, VIII-10-77, 3♂.

This subspecies ranges from NW Himalayas (Murree-Kumaon), Sikkim and Bhutan. The species is found in Manipur and Naga Hills, Assam, N Burma to Bhamo, S. Shan States, Karens, Yunnan; there are two other subspecies (Evans 1949).

5. **Parnara guttatus mangala** Moore
Lumle, 1615 m, VIII-15-77, 2♂♂ fresh.

This subspecies is found in S & W China (Kiang Si, Kwang Tung, Szechwan, Yunnan), Bokhara, Chitral, NW Frontier (Khyber, Hangu), NW Himalayas (Kashmir-Kumaon), Sikkim, Assam, N Burma, S. Shan States, Hainan (Evans 1949). Sevastopulo (1973) reports grasses, *Oryza, Saccharum,* bamboo, and *Zea mays* (all Gramineae) as foodplants of *P. guttatus.*

6. **Pelopidas sinensis** Mabille
Kalopani to Ghasa, 2440-2010 m, VIII-10-77, 1♂ 1♀ fresh.
Vicinity of Tatopani, 1220 m, VIII-11-77, 1♂ fresh.

It occurs from Shanghai to S & W China, NW Himalayas (Kulu-Kumaon), Sikkim, Assam, S. Shan States (Evans, 1949).

We found no skippers above *c.* 2285 m, and a total lack of skippers in the alpine zone. Shirozu (1955) reports no skippers above *c.* 2285 m in the Thakkhola and Manang regions of central Nepal too. Mani (1962, 1968) and Mani & Singh (1962) make no mention of any high elevation skipper records in their Lepidoptera Himalayan summaries. *Hesperia alpina* was taken at Batura (3100-3600 m), western Karakorum (Evans 1927). In Tibet, by con-

trast, skippers are reported up to 2440-3200 m (Evans 1915), 3359-3660 m (Riley 1927, 2 sp.), and in SE Tibet, 2745-4570 m (South 1913, 11 sp.). The reason for this difference is unresolved. An abundance of grasses appear available to them in the alpine zone, so their absence is puzzling.

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A REPORT ON A COLLECTION OF AMPHIBIANS AND REPTILES FROM THE PONMUDI, KERALA, SOUTH INDIA

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(*With five plates*)

[*Continued from Vol.* 81(2): p. 427]

Rana temporalis (Günther) (Plate IV)

Hylorana temporalis Günther, 1864, Rept. Brit. India, p. 427, pl. 26, fig. G—Ceylon.

Rana temporalis Boulenger, 1882, Cat. Batr. Sal. Brit. Mus. p. 63.

Material. 7 adult females 71.0-79.3 mm SV, mean 76.8; 17 adult males 42.9-54.6 mm, mean 50.6; 102 juveniles 13.4-47.0 mm. Tibia 0.56-0.60 of SV in females, mean 0.580, 0.53-0.60 in males, mean 0.558.

The dorsal color pattern of juveniles consists of a light tan band between the dorsolateral folds and sharply contrasting dark brown sides. As the animals mature, this color pattern gradually gives way to a more generally brown dorsal color, so that in some large females, the dorsal and lateral color is uniform dark tan.

Males have greatly enlarged nuptial pads on the medial side of the first finger, and a large, flat, oval gland on the inner surface of the upper arm. Of our 7 mature females only 2 contained large, pigmented ova.

Larvae. A complete developmental series from Stage 29 through metamorphosing individuals, and all size stages to adults confirms the assignment of seven samples of tadpoles to *Rana temporalis.* These larvae have patches of glands similar to those found in larvae of other species of the *Rana* (*Hylarana*) group.

Head-body oval, narrower near snout than in rear, maximum width midway between eye and end of body, 0.52-0.68 of head-body length; body slightly flattened, depth 0.67-0.73 of width; eyes dorsolateral, not visible from below, eyeball 0.10-0.13 of head-body length (Stages 29-39), interorbital 0.31-0.34 of head-body width, less than eye-snout distance; nostrils dorso-lateral, open, with minute mid-dorsal projection, internarial subequal to interorbital. Oral disk ventral, subterminal, width 0.41-0.52 of head-body width; lower lip with uninterrupted double row of short papillae and 3-6 much longer papillae in each lateral third; upper lip with short papillae in corners; denticles I: 1 + 1/1 + 1: II, the lower rows subequal; divided upper row with wide median gap; beaks black near margins, finely serrated, upper without median convexity. Spiracle sinistral, midway up side, tube fused to body wall, snout-spiracle distance 0.63-0.73 of head-body length. Anal tube dextral, opening level with margin of fin. Tail 1.60-1.83 of head-body length; dorsal margin weakly convex, ventral straight, maximum depth near end of proximal third, depth 0.20-0.26 of tail length, tapering gradually to narrow tip; caudal muscle deeper than fins at basal half; origin of dorsal fin at end of body, dorsal deeper than ventral most of caudal length. An oval patch of whitish glands ventrally on each side at base of hind

limb; an elongate, narrow band of glands dorsolaterally beginning a short distance behind eye and extending almost to end of body. Lateral line pores obscure.

Head-body dark without distinct pattern dorsally, laterally, and anteriorly under the head; tail also dark, with small scattered black spots.

Head-body lengths (mm) : 10.0 (Stage 29), 9.2-11.6 (Stages 30-32), 11.67 (Stage 34), 11.75-12.9 (Stage 39). Maximum total length 33.75 mm (Stage 39). Two individuals in Stage 44 measure 12.2 and 13.2 mm snout-vent.

Ecological Notes. This species was taken from 100 to 800 m elevation. Most (92) individuals were collected in evergreen forest, with a few specimens taken in moist-deciduous (5), gallery (4), moist semi-evergreen (1), and secondary growth (3) forest. The species is common both around streams (56) and away from streams in the forest (47). Most individuals were caught either on dead leaves (44) or small rocks (37); the remainder were collected in such divergent habitats as under leaves, on bare soil, and on the leaves and trunks of small herbs, shrubs, and large trees. Seven samples of larvae were taken along forest streams, 6 of them from sheltered side pools and one from a pothole in a rocky bank.

Philautus charius Rao

Philautus charius Rao, 1937, Proc. Indian Acad. Sci., 6B : 405, fig. 9—Kottigehar, Kadur, Karnataka.

Material. 8 adult females 19.6-22.1 mm SV, mean 20.6; 6 adult males 16.5-18.8 mm, mean 17.2. Tibia 0.48-0.59 of SV in females, mean 0.534; 0.48-0.56 in males mean 0.527.

A small, relatively slender frog with a sharply pointed snout. Fingers are completely free of webbing with large, well-developed disks, from one and one-half to two times width of the subterminal phalanx. Feet are barely one-third webbed, with webbing not reaching to the second subarticular tubercle on fourth toe; a vestige of webbing between toes 2 and 3, and none between toes 1 and 2. Disks on toes about one and one-half times width of subterminal phalanx. In our sample, there appears to be sexual dimorphism in the amount of webbing, with males having somewhat less webbing than the female described above. Above skin smooth, with small tubercles on eyelid and snout; often extending onto the lateral and dorsal surfaces. Belly granular; throat smooth in females, granular in males. Males with well-developed nuptial pads.

Dorsal color pattern a dark brown background with various amounts of light brown or tan and deep brown on back. Often a pair of dark lines between eyes and groin enclosing an hourglass-shaped area sometimes filled with light brown. Forearms, thighs, calves, and feet heavily barred with dark brown. A dark spot on sides of body always present, forming a continuation of largest leg bar when limbs flexed into normal sitting posture. Ventral surface white with variable amounts of dark brown flecking, forming a vermiculated pattern across belly in darkest individuals.

Taxonomic Notes. These frogs do not precisely fit Rao's description (1937), which provides no indication of the amount of intraspecific variation. Our material differs from the type in having less webbing (one-third to one-half webbed in the type) and in size (the type is 23 mm SV, while our largest individual is only 22.1). Rao's description of the interorbital space relative to the eyelid and distance between the eye and nostril does not coincide with his figure of the type; our animals are similar to his figure. However, since our locality is nearly 600 km south of the type locality, such differences between the type and our specimens is not surprising.

Ecological Notes. All but 2 of our 14 specimens came from evergreen forest between 290 and 650 m; the remaining 2 were collected in moist-deciduous forest at 300 m. All specimens were found far from water on the forest floor, either on the surface of dead leaves (9 specimens) or beneath leaves or logs (4).

Philautus femoralis (Günther)

Ixalus femoralis Günther, 1864, Rept. Brit. India, p. 434, pl. 26, fig. D—Ceylon.

Rhacophorus (*Philautus*) *femoralis* Ahl, 1931, Das Tier., Lief. 55 : 73.

Material. 3 adult females 23.3-24.0 mm SV, mean 23.6; 18 adult males 19.4-22.8 mm, mean 20.9. Tibia 0.48-0.53 of SV in females, mean 0.509; 0.49-0.55 in males, mean 0.513 (n = 11).

Habitus slender, snout relatively short and rounded. Canthus rostralis moderate, lores not or only very slightly concave. Upper eyelids relatively small, much narrower than interorbital distance. Tympanum barely visible; no supratympanic fold. Toes about three-fourths webbed with webbing extending to disk on fifth toe, and to disks on lateral sides of third and fourth toes (occasionally only to distal subarticular tubercle on fourth toe); webbing to between middle and distal subarticular tubercle on medial side of fourth toe. A rudiment of webbing between fingers. Disks of fingers well developed, about one and one-half times width of penultimate phalanx; those of toes less than one and one-half times diameter of penultimate phalanx. Skin smooth dorsally, granular beneath, with a granular throat in males only. Males have a well-developed nuptial pad on the first finger.

Dorsal color pattern variable, ranging from uniform deep purple (in preservative) through a series of patterns of purple-brown spots on a tan background to uniformly tan, with only a dark streak along side of head. In the purple individuals (most of the series), the same color is found on the upper surfaces of the forearms and calves, and a thin line of purple extends the length of the thigh and foot. Lower arm, most of thigh and foot, and sides are immaculate yellowish-white, as are the hands. In those individuals with a spotted or tan dorsum, the limb coloration is also more diffuse, with purple areas often represented as a tan series of crossbars on the forearm and calf. Ventrally all individuals immaculate yellow-white. Males have a well developed nuptial pad on the first finger.

In life, these frogs go through a striking shift in color pattern which is reflected in the variation in preserved animals. Freshly caught specimens are invariably a uniform leaf-green (purple in preservative), with yellow-cream sides (Plate IV). As the animals are held in captivity, the color shifts to brown with cream dorsolateral stripes (Plate V); the spotted individuals presumably represent those in the process of changing color.

Taxonomic Notes. We have compared our frogs with the types of *Philautus femoralis* (Günther), *P. fergusoni* (Günther), *P. pulchellus* (Günther), and *P. beddomii* (Günther) : all but the last species were placed in the synonymy of *P. femoralis* by Boulenger (1882). The types of *P. pulchellus* and *P. fergusoni* are in a poor state of preservation, and can only be said to agree with our material and with the type of *P. femoralis* in general habitus and the overall purple coloration. Our material agrees with the type (BMNH 1947.2.26.89) of *femoralis* very closely in size, color pattern (the type has the common, uninterrupted purple color), and webbing. As in *P. temporalis* (see below), our specimens have a more pointed snout in profile than the type, which appears to be an artifact of preservation. Our material is similar in general

color pattern to the *P. beddomi* type series, although these individuals have the purple broadly covering the lower arms, thighs, and feet, a condition never found in our sample. *Philautus beddomi* also differs significantly from our specimens in having much less webbing on the hind feet.

Ecological Notes. We found this species exclusively in disturbed, secondary growth or open grassy situations between 840-900 m. Virtually all specimens were collected from the leaves of 1-3 m tall shrubs, usually far from any stream or pond. The frogs were all collected at night, generally by following calling males, which explains the very uneven sex ratio in our sample.

Philautus signatus (Boulenger)

Ixalus signatus Boulenger, 1882, Cat. Batr. Sal. Brit. Mus., p. 106, pl. 11, fig. 2—Malabar.

Rhacophorus (*Philautus*) *signatus* Ahl, 1931, Das Tier., Lief. 55 : 77.

Material. 1 adult female 27.0 mm SV, 10 adult males 21.2-23.1 mm, mean 22.0. Tibia 0.54 of SV in female; 0.49-0.53 in males, mean 0.521.

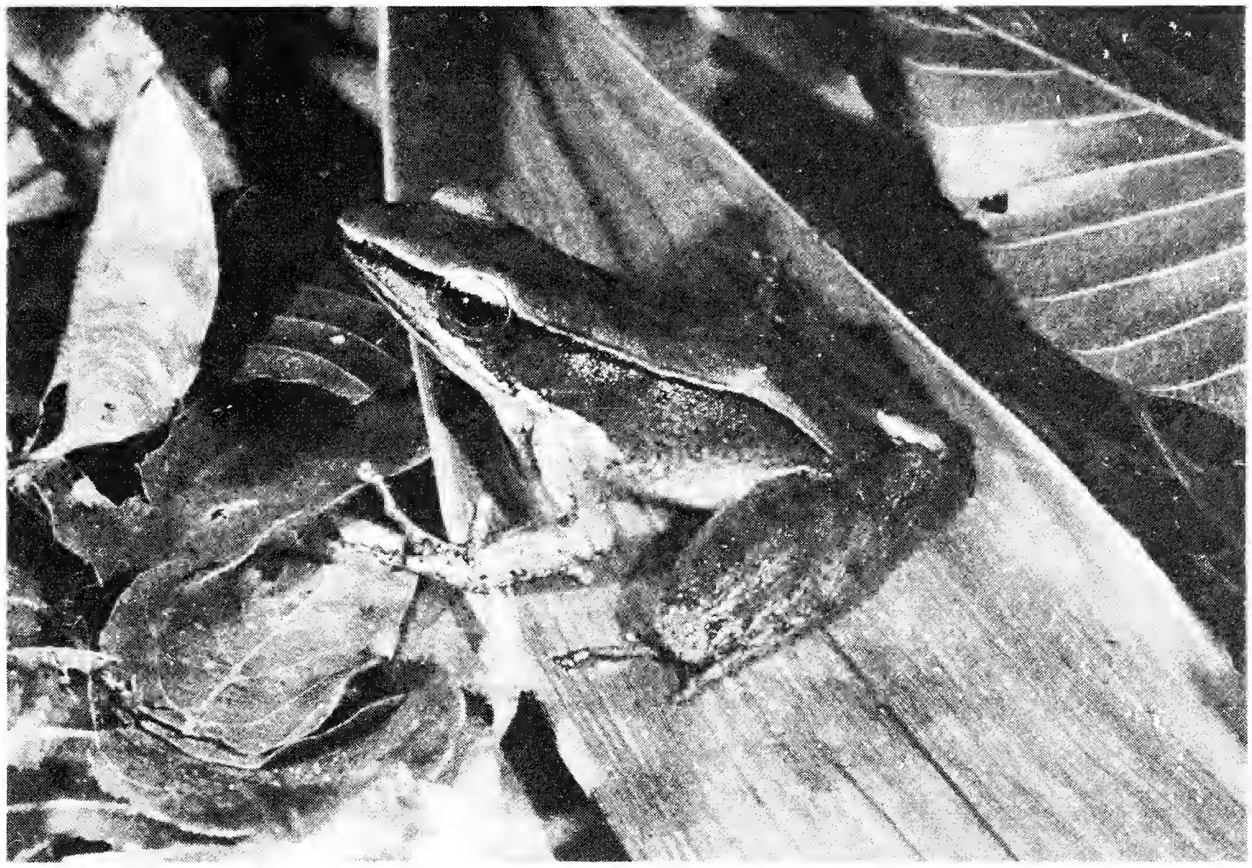
Overall habitus stocky, relatively robust, with extremely large, protruding eyes, pointed snout, and a sharp, curved canthus rostralis. Toes barely half-webbed, with webbing not quite reaching second subarticular tubercle of fourth toe, and no webbing present on first toe. Disks of toes moderate, about one and one-half times diameter of penultimate phalanx. Fingers without webbing; subarticular tubercles prominent. Disks of fingers about one and one-half times width of finger. The skin smooth above, coarsely granular below, granulations extending onto underside of thighs near groin. As in most *Philautus,* the throat is smooth in females, granular in males.

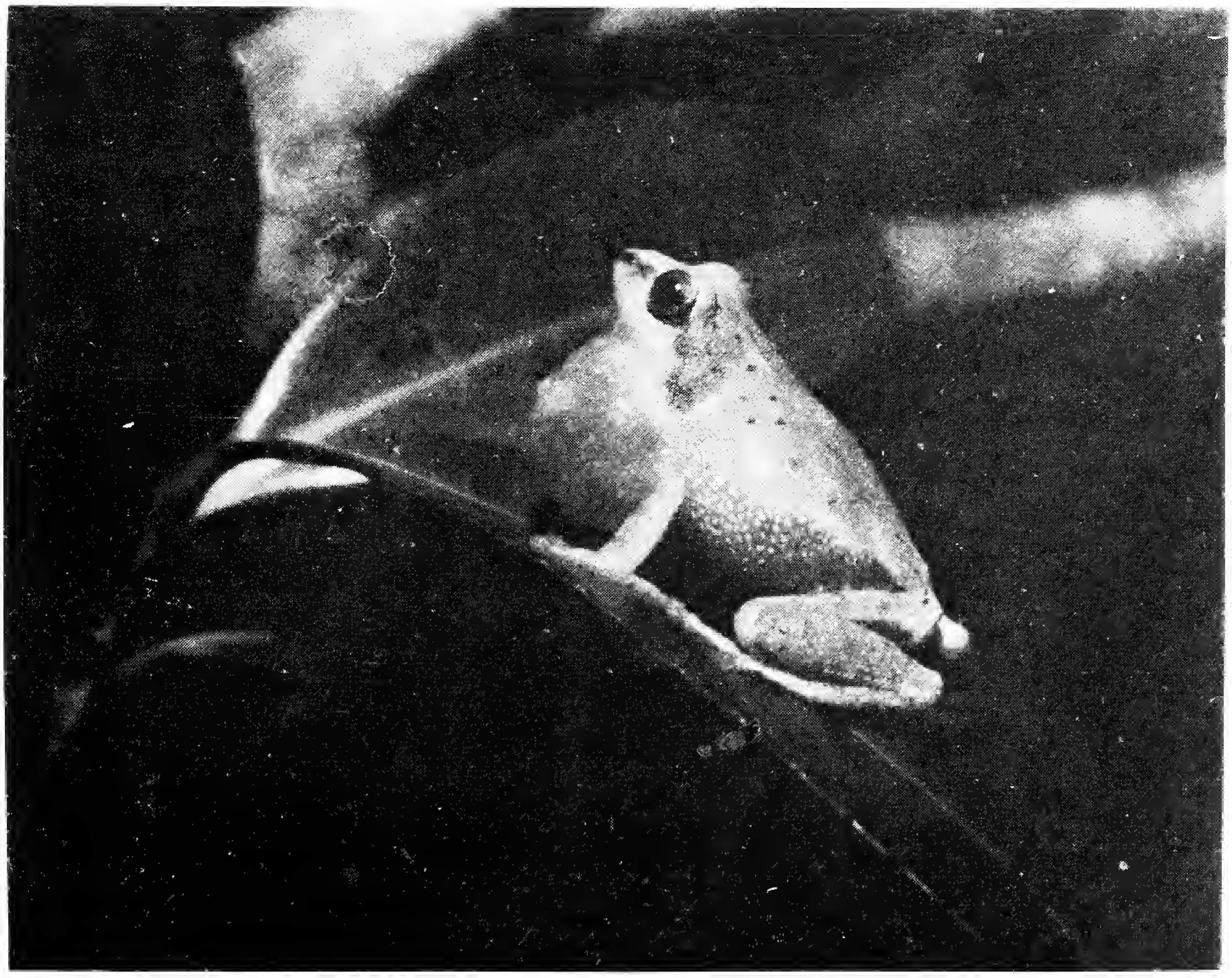
Dorsally all individuals brown with a few irregular dark brown markings in temporal region. A faint pair of brown spots about one-half the diameter of the eye often present in scapular area. "X" pattern on the back is variably present, consisting of a dark, hourglass pattern of light brown starting at eyes and extending the length of back. Front and hindlimbs barred with dark brown, barring generally becoming a brown marbling pattern on yellow-brown background color along posterior surface of thighs. Ventral coloration white with tiny black flecks; more densely concentrated on the throat and underside of the thighs, producing a dusky coloration.

In life, dorsal surface pale brown, the side of the head with small, dark flecks. The inguinal region and anterior surface of the thigh vermiculated with black-brown; the rear of the thigh yellow-green with black reticulations. The iris is silvery, with turquoise along its dorsal margin.

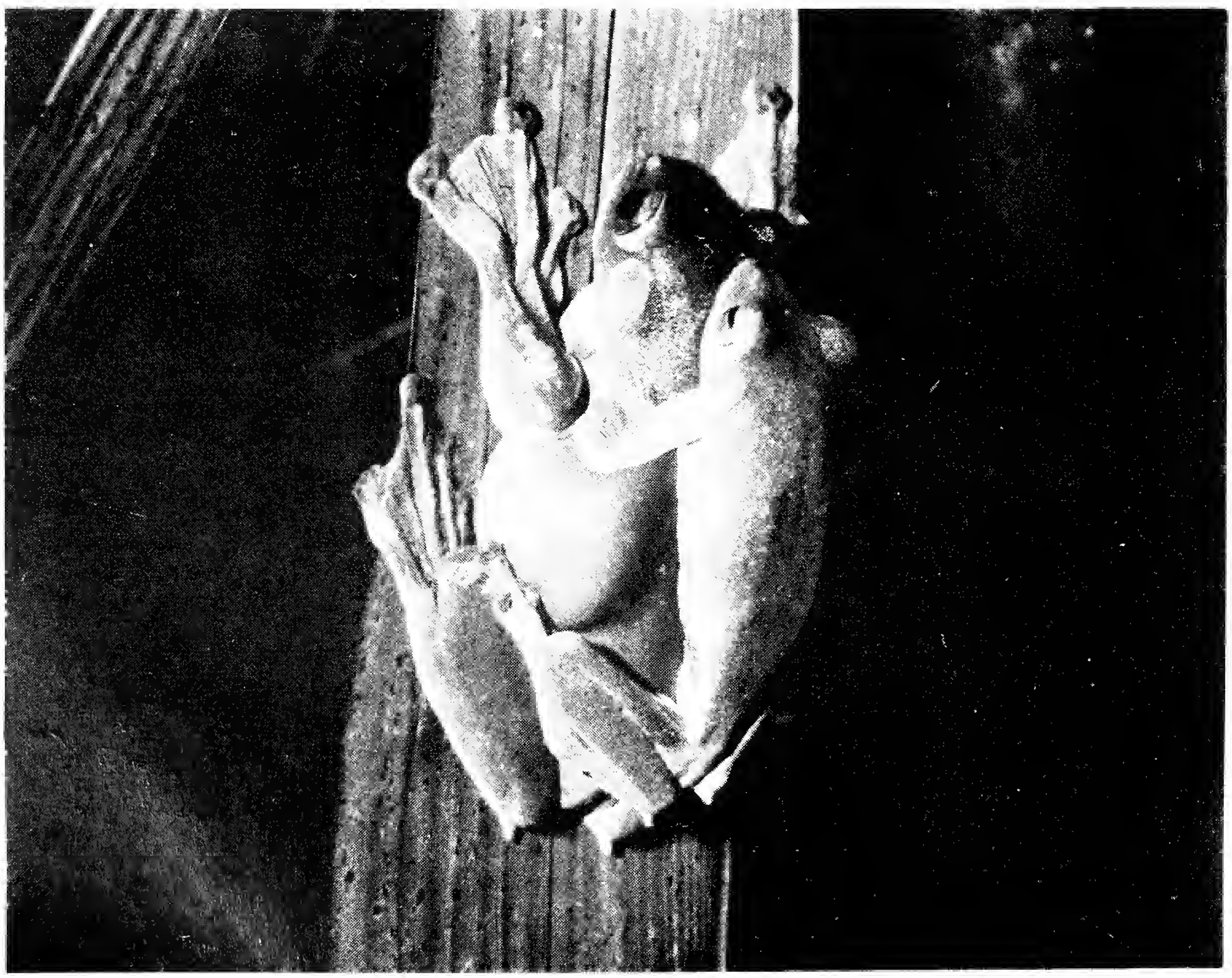
The distinctive marbled pattern of the groin illustrated by Annandale (1919) is not always present. In our material, the single female has a strong pattern of dark brown reticulations along the anterior side of the thigh and on the groin, extending along the lateral surface of the body one-half the distance of the axilla. This pattern is present in a reduced form in a single male (RFI-30931); otherwise the groin is light tan with occasional dark smudges.

Taxonomic Notes. The designation of these frogs is questionable, primarily because of the lack of a lingual papilla in our series. However, the extent of variation, both geographically and within populations, in this structure has never been adequately documented. Annandale (1919) noted that the papilla varies from inconspicuous to prominent in the related *P. bombayensis,* and Kirtisinghe (1957, p. 12) does not consider this character to be of specific value. Otherwise, our material





Above: Rana temporalis.
Below: Philautus femoralis. Typical colour phase when calling.



Above: Philautus femoralis. Dark color phase.
Below: Rhacophorus malabaricus. A pair in amplexus.

agrees well with Boulenger's description, and with Wall's (1922) account of the call and general habits.

Ecological Notes. As with *P. femoralis,* this species was collected in open grassy areas between 920-950 m, far from any stream or pond. However, unlike *P. femoralis,* few individuals were found on small shrubs (3). Instead, most specimens were collected under leaves (1), on the soil surface (5), or on rocks (2). Whether this represents a case of ecological displacement between these two species deserves additional attention. Most specimens collected were calling males.

Philautus temporalis (Günther)

Ixalus temporalis Günther, 1864, Rept. Brit. India, p. 434 pl. 26, fig. E—Ceylon.

Rhacophorus (*Philautus*) *temporalis* Ahl, 1931, Das Tier., Lief. 55 : 97.

Material. 5 adult females 25.4-26.2 mm SV, mean 25.7; 13 adult males 18.7-25.6 mm, mean 21.1. Tibia 0.50-0.53 of SV in females mean 0.513; 0.47-0.56 in males, mean 0.498.

A small, slender species with pointed snout, sharp, slightly curved canthus rostralis, and weakly concave lores. A distinct, curved supratympanic fold from eye to shoulder. Tympanum very distinct, about half diameter of eye in both males and females. Feet about one-third webbed, webbing reaching second subarticular tubercle on fourth toe, barely to tubercle on first and second toes. Fingers completely free of webbing. Subarticular tubercles weakly developed on both fingers and toes. Skin smooth above, granular below, with a granular throat in males.

Greyish brown to brown dorsally and laterally, generally with a distinct pattern of darker brown longitudinal bars and spots. Markings frequently form an irregular hour-glass pattern extending from eyes to groin. A very distinct black stripe along the supratympanic fold, extending forward onto the loreal region. Front and hind limbs light tan with brown bars. Ventrally white with flecks of black on belly, more dense on the throat, forelimbs, and thighs. In life, sandy reddish brown above; lores, tympanum and streak below the supratympanic fold dark brown.

Taxonomic Notes. Our material agrees very closely with types of *P. temporalis* (BMNH 1947.2.6.8, 10-11) in size, coloration, webbing, and general habitus. The only point of difference is in the shape of the snout in lateral view, which is pointed in our material and relatively blunt in the types. However, in two (BMNH 1947.2.6.10-11) the snout is obviously distorted, with the tip flattened, and it is probable that the shape of the snout is an artifact of preservation.

In retaining the name *P. temporalis,* we follow Ahl (1931) as the last reviewer of the genus. Since we have not examined the types of *P. leucorhinus,* we cannot judge the distinctness of these two species.

Ecological Notes. This species uses a wide range of altitudinal and vegetational habitats; specimens were collected from 130 to 900 m in open grassy areas (7), secondary growth (4), evergreen forest (6), and deciduous forest (1). About half (8), all calling males, were found in shrubs or seedlings 0.3 to 2.0 m above the ground. The remaining half were found on the ground, either on dead leaves or bare soil; of these, half were females.

Philautus variabilis (Günther)

Ixalus variabilis Günther, 1858, Cat. Batr. Sal. Brit. Mus., p. 74-75, pl 4, fig. A, B—Ceylon.

Philautus variabilis, Roux, 1928, Rev. Suisse *Zool.,* 38: 464.

Material. 2 adult females 30.3, 31.0 mm SV; 2 adult males 27.0, 28.5 mm. Tibia 0.52 of SV in females; 0.52, 0.53 in males.

Hind feet about two-thirds webbed, with

webbing extending to second tubercle on both sides of fourth toe, and distal tubercle on fifth toe. A slight rudiment of webbing between fingers. Tips of fingers expanded into broad disks twice as wide as the penultimate phalanx. Disks of toes narrower than those of fingers, about one and one-half times as wide as penultimate phalanx. One specimen has a series of small bumps or short ridges on the snout and eyelids, and sparser ridges on the back; the others are perfectly smooth above. Below, the skin is granular on the belly, around the anus, and on the throat of males.

Our 4 specimens cover a remarkable range of color patterns. The dorsal surface ranges from light tan to dark brown, with or without a large, dark brown, inverted "V" pattern on the back, from the front limbs nearly to the groin. A dark interorbital band may be present. At least a hint of dark marbling along sides near groin extending well onto lateral body surfaces and thighs, or confined to immediate region of groin and back of thighs. Ventrally white suffused with black flecks, very sparse or coalescing into dark brown-black reticulation over entire surface. A more or less well defined barring pattern present on the legs and feet.

Taxonomic Notes. We have compared these specimens to the holotype of *P. adspersus* (Günther) (BMNH 1947.2.6.23), and find them to match in all essentials except the color pattern, which is brown with an irregular pattern of brilliant, enamel white spots in *adspersus* (see Boulenger, 1882, pl. 10, fig. 8). While the color pattern of *adspersus* is strikingly different from that of *P. variabilis,* the latter species is so variable that we feel the recognition of a related species purely on color pattern must be considered suspect. We thus refer our material to *P. variabilis.*

Ecological Notes. Of our 4 specimens, 3 were collected in evergreen forest (1 at 310 m, 2 at 950), and one was collected in gallery forest. As in all of the *Philautus* in our collection, these frogs were found away from streams or ponds. Two individuals were on the leaves of trees 2-2.5 m above the ground, and one was on dead leaves on the ground.

Rhacophorus malabaricus Jerdon (Plate V)

Rhacophorus malabaricus Jerdon, 1870, Proc. Asiatic Soc., Bengal, 84 — Malabar.

Material. 1 adult female 95.8 mm SV; 8 adult males 61.9-73.5 mm, mean 68.8. Tibia 0.50 of SV in female; 0.48-0.54 in males, mean 0.50.

In life, a bright leaf-green above and white below. Webbing of hand a pale orange-red, feet a more intense, nearly blood-red. A white line along outer edge of forearm, tarsus, and foot; triangular heel appendage white. In preservative, upper surfaces purplish, webbing fading to white. In several individuals numerous small white spots dorsally.

Males with a well-developed nuptial pad on the medial side of the first finger. In our series, the testes are greatly enlarged to 0.18-0.23 of SV. The single female contained numerous mature, unpigmented eggs.

Larvae. Six samples of larvae, extending from Stage 25 to premetamorphosis (Stage 42), fit Ferguson's (1904) description well. The most advanced larvae have fully webbed outer fingers.

Head-body lengths (mm) : 9.25 (Stage 26), 12.9-14.2 (Stages 31-32), 14.75 (Stage 36), 15.75-16.8 (Stages 38-39). Maximum tail length 46.67 mm (Stage 38). Tail length 1.72-1.95 of head-body length (3 individuals). Denticles of upper lip II : 5+5 (6 tadpoles) or II : 6+6(1); of lower lip 1+1 : II(7).

Ecological Notes. We found this frog in two different circumstances. One pair was

collected in evergreen forest, 350 m elevation, 3 m above a side pool in a stream flood plain. Foam nests were attached to vegetation several meters above the pool and tadpoles in various stages of development were collected there. Our other 7 specimens were collected from trees and shrubs (1-4 m above the ground) surrounding a small pond (approximately 8 m diameter and 1.5 m deep) formed by damming a 1 m wide stream in a disturbed area at 800 m elevation. The frogs were using this pool for breeding (Plate V), and numerous foam nests were seen in the leaves of trees surrounding the pond.

Two samples of tadpoles were reared from foam nests, one of which was attached to a palm frond overhanging a stream side pool and the other plastered against the rock wall above a pot-hole on a stream bank. The other free-swimming samples were obtained in stream side pools (3 samples) and in a rocky pot-hole on a stream bank.

Hemidactylus frenatus Schlegel

Hemidactylus frenatus Schlegel, *in* Dumeril & Bibron, 1836, Erp. Gen., 3: 366—Java; Smith, 1935, Fauna Brit. India, Rept., 2: 95.

Material. 2 females 61, 67 mm SV, 3 males 58-65 mm, 1 juvenile 28 mm. Tail 0.90-1.12 times SV (n=4). Femoral pores in males 37(2), 41, without a preanal gap. Supralabials 11(3), 12(2). All individuals with conspicuous rounded dorsal tubercles.

The fact that these geckos were found in forest rather than in houses obliged us to confirm the identification by comparison with *frenatus* from various parts of southern Asia. The color of one in life—underside of tail orange, chest yellow, tinged with orange—agrees well with Smith's notes (1935).

Ecological Notes. The juvenile was found on a small tree trunk (12 cm) 2 m above ground in deciduous forest. All 5 adults were in evergreen forest at 310-360 m. One was on soil at the base of a tree buttress, the other 4 on tree trunks 2-4.5 m above ground. The trees measured 10, 80, 85, 110 cm DBH.

Cnemaspis ornata (Beddome)

Gymnodactylus ornatus Beddome, 1870, Madras Jour. Med. Sci., 1870, 1: 32—Tinnevelly, India.

Cnemaspis ornata Smith, 1935, Fauna Brit. India, Rept., 2: 70.

Material. 9 females 46-56 mm SV, mean 52.0; 3 males 50-55 mm, mean 53.0; 2 juveniles. Tail 1.04-1.22 times SV in the 3 with complete, original tails. Enlarged scansors under fourth toe 3-4, the distal one much larger than the others but not projecting. Males with 8-10 preanal pores.

This series agrees well with Smith's (1935) description. In life, the light areas of the head, neck, and shoulders are yellowish green except for 2 pairs of white rectangular scapular spots. The color changes abruptly behind the shoulders to bluish grey with darker flecks.

Ecological Notes. Twelve of our animals were collected at 950 m, 1 at 660 m, and 1 at 300 m. All were in moist-evergreen forest, contrasting with Beddome's statement that this species occurs only in "dry jungle' (Smith 1935). Ten were caught during daylight hours, 5 under rocks, 1 in a rotting log, 1 on a rock, and 3 low on tree trunks. The 4 captured at night were on large rocks (3) and on a tree trunk. The rocks with which these lizards were associated were large, 6 of them 1-2.5 m across.

Cnemaspis littoralis (Jerdon)

Gymnodactylus littoralis Jerdon, 1853, Jour. Asiatic Soc. Bengal, 22: 469—Malabar.

Cnemaspis littoralis Smith, 1935, Fauna Brit. India, Rept., 2: 76.

Material. 2 females, one with mature ova, 33, 34 mm SV; 1 male 33 mm. Tail 1.12 times SV in one having an original tail. Male with 16/17 femoral pores, 12 scales separating the

series. Scansors 5-7 on fourth toe. As Smith (1935) noted, the distal scansors of the basal phalanges are strikingly enlarged.

Ecological Notes. All 3 were caught on tree trunks 0.25-1.5 m above ground during daylight hours, 2 in evergreen forest (310-360 m) and one in moist deciduous forest (260 m).

This is the first record of *littoralis* from the southern part of the Western Ghats.

Cnemaspis nairi Inger, Marx and Koshy

Cnemaspis nairi Inger, Marx & Koshy, 1984, Herpetologica, 40: 149 — Ponmudi, Kerala.

Material. 7 females 37-43 mm SV, 3 males 31-41 mm, 7 immature. Means and counts given in Inger *et al.* (1984).

Ecological Notes. This species was collected from 280 to 925 m, most animals coming from 310-360 m. They were caught mainly in evergreen forest (11), the remainder in moist-deciduous forest (1), thin secondary growth (2), gallery forest (1), and at the edge of a grassy area (1). Seven were found under rocks or logs and 2 under slabs of bark on a large log. Three others were caught on large rocks, 3 on floor litter, and 2 low (0.1 m) on tree trunks.

Cnemaspis tropidogaster (Boulenger)

Gonatodes kandianus tropidogaster Boulenger, 1885, Cat. Lizards Brit. Mus., 1: 70—Ceylon and Tinnevelly, Nilgiris, and Wynad, India.

Cnemaspis kandiana (part) Smith, 1935, Fauna Brit. India, Rept., 2: 74.

Material. 132 individuals; 40 females 26-35 mm SV, smallest with enlarged ova 29 mm, mean of those $>$ 28 mm 31.7 ($n=33$), 14 were gravid; 53 males 26-33 mm, mean 29.9. Information on counts and taxonomic relationships given in Inger *et al.* (1984).

Ecological Notes. Six geckos were found in moist-deciduous forest, 1 in a gallery forest, and the rest in evergreen forest. Altitudinal range was: 110-145 m—5, 265-290 m—3, 300-370 m—77, 450-570 m—11, 660 m—3, 870-950 m—33. Ninety one were caught on tree trunks, 42 within 1 m of the ground and only 5 above 2 m. Fourteen were caught on large rocks, 11 on dead leaves or on bare soil, and 13 under rocks or floor litter. Twelve of the 13 found on bare soil or on or under leaves were within buttress-enclosed areas.

Draco dussumieri Duméril & Bibron

Draco dussumieri Duméril & Bibron, 1837, Erp. Gén., 4: 456—Malabar; Smith, 1935, Fauna Brit. India, Rept., 2: 143.

Material. 2 females 85, 87 mm SV, 2 males 72, 74 mm. One male was caught in a tree at an unknown height in a village (100 m) and the others in trees about 8 m above ground in evergreen forest (350-360 m). One male and a female were caught in the same tree (45 cm DBH).

Otocryptis beddomi Boulenger

Otocryptis beddomi Boulenger, 1885, Cat. Lizards Brit. Mus., 1: 272—Sivagiri Ghat, India; Smith, 1935, Fauna Brit. India, Rept., 2: 147.

Material. 27 females, 4 lacking enlarged or yolked ova measure 30, 32, 33, 36 mm (first 3 subadult), 24 adult females 36-42 mm SV, mean 39.4; 28 males, smallest (probably subadult) 31 mm, adults 34-43 mm, mean 37.8. Difference between means statistically significant ($t=2.51$, $P < 0.02$).

Tail length 1.45-1.71 times SV, mean 1.62 ($n=9$). Foot length 0.40-0.47 times SV, mean 0.44 ($n=12$). Pit before shoulder distinct. Males occasionally with puffed gular sac, but never with distinct gular appendage. Coloration as described by Smith (1935) except that males have a distinct light vertebral band.

Ecological Notes. Twenty-two gravid females contained 3-5 near term ova each (mean 3.55). That such a high proportion was gravid and that we found no hatchlings indicate that the period of oviposition is restricted and was about to begin.

Seven individuals were caught in moist-deciduous forest, the rest in evergreen forest. Forty-one were collected at 300-365 m, 9 below that level (to 110 m) and 5 above (to 650 m). The bulk (32) were seen scampering over leaf litter. Only 14 were observed on shrubs (4) and trees (10), only 2 of these more than 1.5 m above ground and 7 below 1 m.

Psammophilus blanfordanus (Stoliczka)

Charasia blanfordana Stoliczka, 1871, Proc. Asiatic Soc. Bengal, 1871: 194—Central India.

Psammophilus blanfordanus Smith, 1935, Fauna Brit. India, Rept., 2: 210.

Material. 2 females 66, 71 mm SV, 1 male 104 mm. The tail of the male, the only individual with a complete tail, measured 209 mm. Scale rows 97-103. Scales under fourth toe 19-21.

Ecological Notes. One lizard was caught in deciduous forest (115 m), 1 in a rubber planting (280 m), and 1 in an agricultural clearing (550 m). All were on large rocks (3-5 m) when first seen.

The two females contained developing ova, the larger individual 4 and the smaller 6.

Calotes calotes (Linnaeus)

Lacerta calotes Linnaeus, 1758, Syst. Nat., ed. 10, 1: 207—Ceylon.

Calotes calotes Lonnberg, 1896, Bih. Svensk. Vet. Akad., 22: 15; Smith, 1935, Fauna Brit. India, Rept., 2: 201.

Material. 1 female 98 mm SV, 1 juvenile 41 mm. Tail 3.52 times SV in the female, 3.17 in the juvenile. Scale rows 31, 34. Scales under the fourth toe 29, 31.

Ecological Notes. The juvenile was caught in a rubber planting on the stem of a tall herb 1 m above ground. The female was caught at 9.7 m above ground on a branch of a tree (22 cm) in partly logged evergreen forest. Elevations were 145 and 265 m respectively.

Calotes nemoricola Jerdon (Plate VI)

Calotes nemoricola Jerdon, 1853, Jour. Asiatic Soc. Bengal, 22: 471—Coonoor Ghat, Nilgiri Hills; Smith, 1935, Fauna Brit. India, Rept., 2: 199.

Material. 2 males 108, 110 mm SV. Tail 2.34, 2.40 times SV. Scale rows 39, 42. Scales under fourth toe 23, 28. Both were olive-green when caught, one quickly turning brown. The throat was orange-red in one.

Ecological Notes. One lizard was caught in a sapling (3 cm diameter) 2 m above the ground in a moist-deciduous forest (280 m). The second was caught at night asleep clinging to a slender branch of a shrub 1 m above ground in an evergreen forest (310 m).

These specimens appear to be the first of this species collected in the southern part of the Western Ghats, about 300 km south of the type locality.

Calotes rouxi Duméril & Bibron (Plate VI)

Calotes rouxi Duméril & Bibron, 1837, Erp. Gén., 4: 407—India; Smith, 1935, Fauna Brit. India, Rept., 2: 206.

Calotes elliotti Günther, 1864, Rept. Brit. India, p. 142—Malabar; Smith, 1935, Fauna Brit. India, Rept., 2: 207.

Material. 19 females 56-71 mm SV, mean 62.8; 4 males 63-66 mm, mean 64.5, 2 juveniles 26 mm. Tail 2.49-2.87 times SV in 16 individuals having complete tails. Scale rows 51-65, mean 58.7 (n=20); difference between the sexes not significant: males 52-65, females 51-65.

The throat and underside of the head may be rose or orange-red in both sexes; in several individuals these areas faded to whitish a short time after capture. Similarly, the enamel white spot on the upper lip of some individuals faded to dirty whitish.

Taxonomic Notes. Specimens collected by us are variable with respect to the two diagnostic characters used by Boulenger (1885) and Smith (1935) to distinguish *C. elliotti* from *C. rouxi*: a small spine behind the supraciliary ridge and a white spot below the orbit (see

tabulation).

	Post-orbital spine		
	Present	Present on one side only	Absent
Subocular white spot			
Present	1	2	5
Absent	2	5	5

There is no association among these characters as would be expected from Smith's key and description. No meristic differences between the two nominate forms appear in the descriptions of Boulenger or Smith. In our sample, the three with postorbital spines on both sides had 55-64 scale rows and 27-31 scales under the fourth toe; in the 10 lacking the spine these counts were 51-65 and 24-30; in the 7 variable lizards the counts were 52-65 and 27-30. Those with a subocular white spot had 52-65 scale rows and 24-30 scales under the fourth toe, those without the spot 51-65 and 27-31. Differences between pairs of data sets are not statistically significant.

In all other features Boulenger's and Smith's descriptions of the two forms are completely congruent and our sample permits no dichotomy on the basis of any character. We believe only a single species is involved.

Ecological Notes. Only 6 of the 25 collected were in non-arboreal positions: 3 on dead leaves (2 in buttress-enclosed areas) and 3 on rocks. The remainder were on small stumps (2), shrubs 0.5-3 m above ground (8), and on tree trunks 1-7.5 m high (9). Three were captured at night while sleeping on the midribs of shrubby palm fronds. Altitudinal range was extensive: 110-145 m—4, 310-350 m—19, 470 m—1, 950 m—1. Those from 110-145 m were caught in deciduous forests, the rest in evergreen.

Clutch size varied from 1 to 3, mean 2.3 (n=18).

Calotes versicolor (Daudin)

Agama versicolor Daudin, 1802, Hist. Nat. Rept., 3: 395—India.

Calotes versicolor Jerdon, 1853, Jour. Asiatic Soc. Bengal, 22: 470; Smith, 1935, Fauna Brit. India, Rept., 2: 189.

Material. 3 females 75-83 mm SV, 3 males 74-94 mm. Tail 2.23-2.81 times SV (n=5). Scale rows 39-43 (n=5). Scales under fourth toe 22-26 (n=5).

Ecological Notes. Two lizards were collected in deciduous forest (130 m), 1 in a semi-open area around buildings (800 m), and 3 in natural grassland (900-970 m). Two were caught on rocks (30-50 cm), 3 on shrubs 1-1.8 m above ground, and 1 on a tree trunk (40 cm) 1.5 m above ground. The largest female contained 5 developing ova.

Mabuya carinata (Schneider)

Scincus carinatus (part) Schneider, 1801, Hist. Amph., 2: 183—no type locality.

Mabouia carinata Boulenger, 1887, Cat. Lizards Brit. Mus., 3: 181.

Mabuya carinata Smith, 1935, Fauna Brit. India, Rept., 2: 266.

Material. 1 female 115 mm SV, 1 male 118 mm, 2 juveniles 50, 66 mm. Tail length of male 223 mm, of larger juvenile 120 mm. Scale rows 32-33. Scales under fourth toe 15. Ventrals 57-63.

Ecological Notes. Two were caught in a natural grassy area at 900 m, 1 in a large camp clearing at 800 m, and 1 in a rubber planting at 290 m.

Mabuya clivicola[1] sp. nov.

Diagnosis. A medium-sized species of *Mabuya* distinguished from all other Indian species of the genus by the following combi-

[1] *clivicola* from *clivus,* hill (L.), and *cola,* dwelling in (L.).

nation of characters: lower eyelid scaly, supranasals widely separated, prefrontals narrowly in contact, dorsals weakly keeled, scales in 28 rows, 17-19 scales under fourth toe, a narrow dark vertebral stripe.

Holotype. Field number RFI 30095, an adult female, collected 8 May 1982 at Ponmudi, Trivandrum District, Kerala at 260 m above sea level. Deposited in NMNHI.

Paratypes. FMNH 216580-81, from the type locality, both adult females, the latter with 3 near term ova.

Description of holotype. Body moderately robust, head and neck of equal diameter; snout obtusely pointed; preorbital length of head equal to distance between eye and ear opening. All head scales smooth; rostral as wide as high, curving up on to dorsal surface of snout, strongly constricted above the rostrolabial suture, posterior margin strongly convex; supranasals narrow, width less than half length, widely separated from each other, end of supranasal behind nasal opening; frontonasal about as wide as long, narrowly separated from frontal by prefrontals; prefrontals meeting at a point, posterior corner separating frontal from first supraocular on left side but not on right, lateral portion curving down on side of head, broadly in contact with both loreals and first supraocular; frontal longer than its distance from snout, broadly in contact with second supraocular on both sides and narrowly with first on right side; frontoparietals as wide as long, touching last 3 supraoculars; interparietal longer than wide, broadly in contact with nuchals; parietals widely separated, bordering last supraocular, 3 temporals, and nuchal; 4 supraoculars, second much the largest, its posterior border transverse, cutting across anterior border of frontoparietal; 5 supraciliaries, the first widest, the third longest; nasal tallest anteriorly, no evident suture behind nostril; first loreal about twice as high as wide, much taller than second, touching first two labials; length of dorsal portion of second loreal greater than height, ventral portion less than height, touching second and third labials; 2 smaller scales between second loreal and large subocular labial; lower eyelid scaly; a row of very small scales between eyelid and subocular labial; 5 postoculars, each about half size of temporals; 6 supralabials, 4 small ones preceding large subocular scale and one following; mental below rostral and first supralabials; a large postmental between mental and first infralabial on each side; 2 large scales on each side behind postmental, both pairs separated in midline by central row of gulars. Ear opening smaller than second loreal, 3 small scales projecting into opening from dorsal portion of anterior border. One pair of rugose nuchals.

Scales in 28 rows; mid-dorsal scales with 5 weak keels; keels without spurs projecting beyond margins of scales; dorsals and ventrals subequal; preanals not enlarged; 46 ventrals between mental and vent; scales on dorsal surfaces of forelimbs smooth, those of hind limbs with 2 weak keels; subdigital scales obtusely keeled; scales on palm and sole rounded; 18 scales beneath fourth toe; dorsal and lateral caudal scales weakly tricarinate; subcaudals not enlarged.

Head, back, and tail olive-brown; a dark vertebral stripe on adjacent halves of mid-dorsal scale rows beginning at shoulder and ending shortly behind rear legs; a dark lateral band beginning at eye as a narrow stripe, continuing over ear, and widening to cover parts of 4 scale rows on trunk; band with a faint light margin dorsally; between eye and shoulder, band with a distinct light stripe ventrally which is in turn bordered by short, thin dark line; between limbs band bordered

ventrally by dark gray area that fades into grayish white of underside; head unmarked ventrally.

Measurements given below.

MEASUREMENTS AND COUNTS

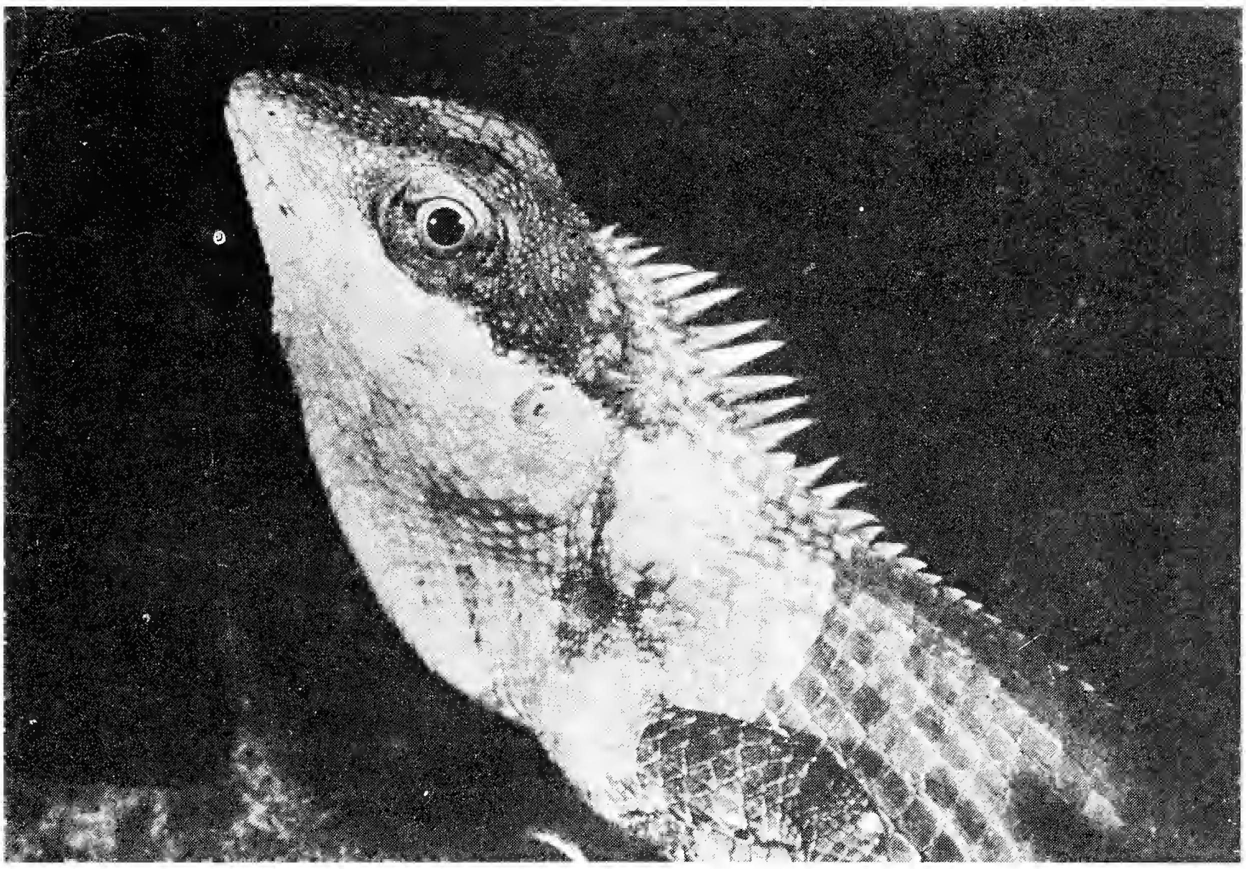
	Holotypes	Paratypes	
	30095	216580	216581
Snout-vent (mm)	53	55	55
Head to ear opening (mm)	10.5	10.5	11
Head width (mm)	8	10	8
Axilla-groin (mm)	27	29	29
Scale rows	28	28	28
Ventrals	46	49	47
Scales under fourth toe	18	17	19

Variation. The paratypes are remarkably similar to the holotype in details of coloration and scutellation. The similarity is noteworthy in the dorsal constriction of the rostral, the narrow contact of the prefrontals, and the transverse border of the second supraocular, which prevents the usual wedging of the frontoparietal between the frontal and supraocular. The rear third of the parietals is rugose in the paratypes. In one (30524) the frontal touches the first supraocular on the right side but not on the left; in the other specimen the frontal is separated from the first supraocular on both sides. In one (31306) the dorsals are weakly 7-carinate.

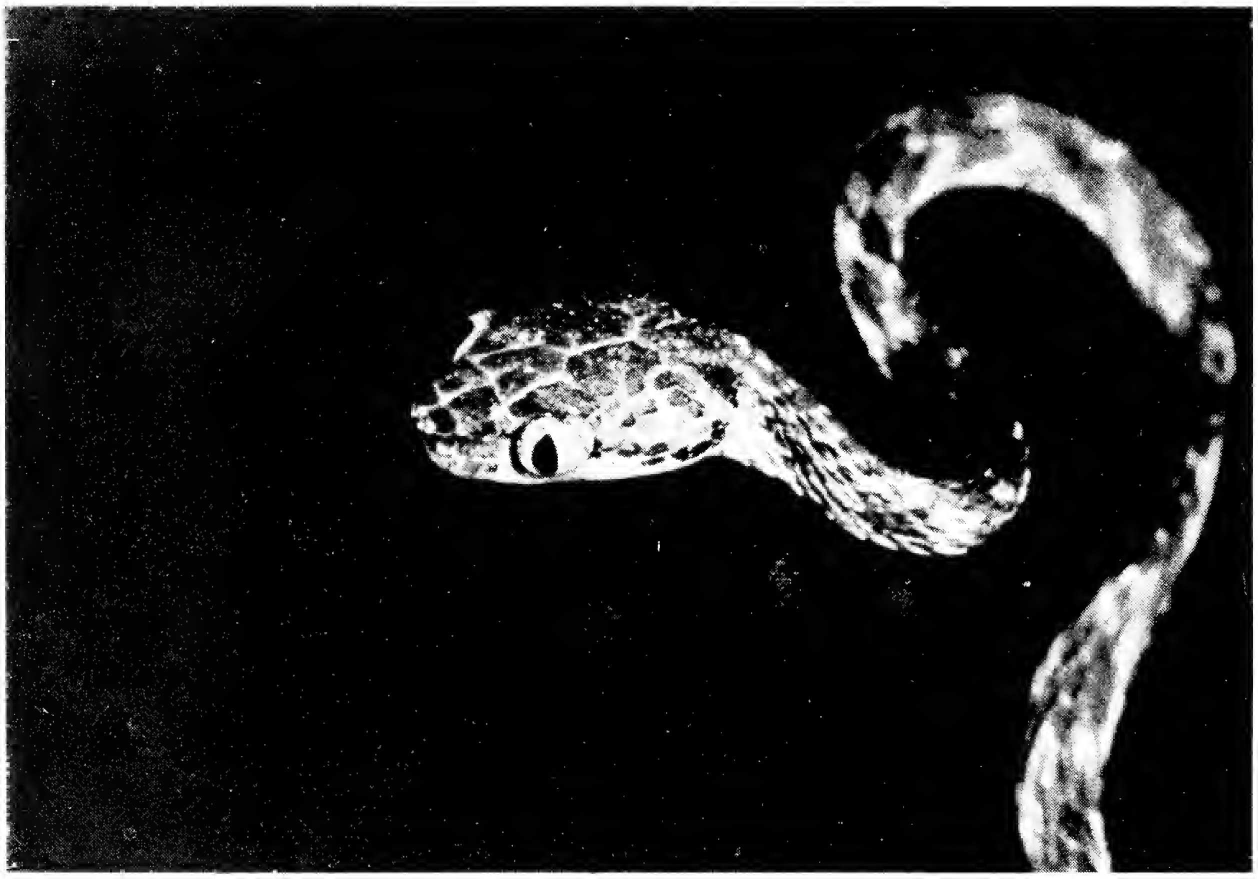
Comparisons. Two other species of *Mabuya* were collected in the same general area, *macularia* and *carinata. Mabuya clivicola* differs from both in having weakly keeled dorsal scales in which, in contrast to the strongly keeled ones of the other two, the keels do not project beyond the rear margins of the scales. It also differs from both in having a single dark vertebral stripe, though *carinata* sometimes has a pair of dark dorsal stripes that run along the outer halves of the middorsal scale rows. *M. clivicola* further differs from *carinata* in having fewer scale rows (30-32 in *carinata*), fewer ventrals (55-63 in *carinata*), and more scales under the fourth toe (only 15 in *carinata*). *Mabuya clivicola* differs from *macularia* in the shape of the rostral, which in *macularia* is gradually narrowed dorsally and not, as in *clivicola,* sharply constricted above the level of the labials; in having the prefrontals meeting; and in having more scales under the fourth toe (13-15 in *macularia*). In *macularia* the frontoparietals are always wedged between the rear of the second supraocular and the frontal; in *clivicola* that does not occur.

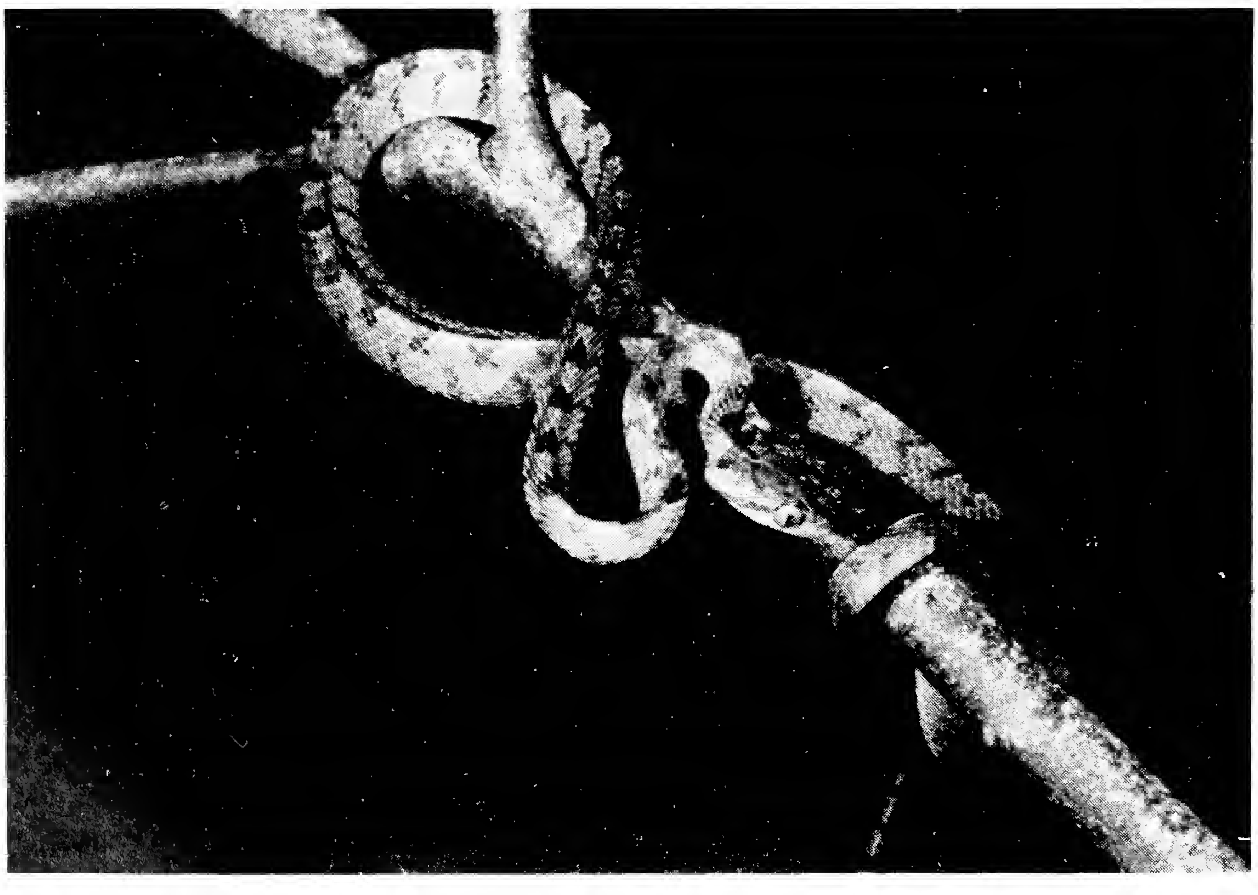
Mabuya bibroni Gray, which occurs along the coastal strand of southern India (Smith 1935), has a clear spectacle in the lower eyelid and further differs from *clivicola* in having strongly keeled scales, 2 pairs of nuchals, a squarish first loreal, and a light vertebral stripe. The other two South Indian species, *M. beddomi* (Jerdon) and *vertebralis* Boulenger, differ from *clivicola* in having the supranasals in contact and more scales (32-36). The boldly striped *beddomi* has more ventrals (55-62) than *clivicola* whereas *vertebralis* has fewer scales under the fourth toe (13-14) and more strongly keeled scales than *clivicola.* Among the more northerly Indian species, *dissimilis* (Hallowell), *aurata* (Linnaeus), and *innotata* (Blanford) differ from *clivicola* in having a spectacle in the lower eyelid and more scale rows (32-38). The supranasals meet in *dissimilis* and *aurata,* while *innotata* has a squarish first loreal; both these character states are absent in *clivicola.*

Ecological Notes. Two specimens of *M. clivicola* were caught in thin secondary growth, one of them on a road (310 m) and the other in a sun spot on bare soil (260 m). The third



Above: Calotes nemoricola.
Below: Calotes rouxi.





Above: *Boiga ceylonensis.*
Below: *Boiga nuchalis.*

was caught on a large rock in an open area of a tea plantation at 350 m.

Mabuya macularia (Blyth)

Euprepes macularius Blyth, 1853, Jour. Asiatic Soc. Bengal, 22 : 652 — Bengal.

Mabuia macularia Boulenger, 1887, Cat. Lizards Brit. Mus., 3 : 182.

Mabuya macularia Smith, 1935, Fauna Brit. India, Rept., 2 : 264.

Material. 88 specimens. Three hatchlings from eggs kept in the laboratory 26-28 mm SV; 25 young, presumably recently hatched, 25-32 mm, 5 additional young 36-41 mm, 3 subadults 48-52 mm; 30 adult females 58-69 mm, mean 62.9; 20 adult males 58-66 mm, mean 62.7. Tail in females 1.22-1.43 times SV (n=3), in males 1.36-1.48 (n=3). Scale rows 28 (12), 29 (2), 30 (1). Ventrals 41-46, mean 43.5 (n=15). Scales under fourth toe 13-15, mean 13.6 (n=17). The coloration of males in life matches the description of *Lygosoma dawsoni* Annandale (1909a), which Smith (1935) placed in the synonymy of *macularia.*

Ecological Notes. Ten of 13 females dissected had developing ova, though only 4 had shelled eggs. Clutch size was invariably 2. We found 8 clutches of 2 eggs each and one of a single egg. The eggs varied in length from 13 to 15 mm, the diameter from 0.69 to 0.81 of length. Eggs were identified to species on the basis of the embryos except for three that hatched in the field laboratory. Smith (1935) gave clutch size as 3-4. As he referred to an ovipositing female from Thailand, it is possible that clutch size varies geographically.

Most (76) of these skinks came from evergreen forest; 5 were caught in thin secondary growth, 4 in moist-deciduous forest, 2 in deciduous forest, and 1 in a rubber planting. Three-fourths (65) were collected between 300 and 370 m, 9 at 110-150 m, 6 at 280-295 m, and 8 at 450-550 m. Except for two individuals (one on a tree trunk at 2.5 m and one on a stump at 0.5 m), all were first observed at the ground level, 6 or rocks, 2 on logs, and the remainder on or under floor litter. Five clutches of eggs were found under dead leaves, 2 under a log, 1 in a rotting log, and 1 in a rotting stump.

Ristella beddomi Boulenger

Ristella beddomi Boulenger, 1887, Cat. Lizards Brit. Mus., 3 : 359, pl. 29, fig. 4 — southwestern India; Smith, 1935, Fauna Brit. India, Rept., 2: 332.

Material. 2 females 36-37 mm SV, 5 males 34-39 mm, 1 juvenile 20 mm. Only one male had a complete tail, 1.35 times SV. Scale rows 26 (2), 28 (5). Ventrals 47-56, mean 50.4 (n=7). Scales under fourth toe 12-15, mean 13.7 (n=7).

Color in life dark reddish brown above; side of body satiny jet black with scattered turquoise scales forming dots; underside of head and neck pale yellow tinged with green, ending at a sharp boundary between forelimbs; remainder of chest, belly, and underside of limbs salmon; underside of tail darker salmon; yellowish eye ring. Juvenile (in preservative) with three narrow, light, dark-edged stripes on back, none on side.

Ecological Notes. Seven lizards were caught in evergreen forest and one in moist semi-deciduous forest at elevations from 190 to 510 m. All were found on forest floor, 3 under dead leaves, 1 on bare soil, and 4 on dead leaves. Three clutches of eggs, assigned to this species on the basis of head scales of embryos, were found under large rocks (2 clutches) and under dead leaves (1) in a buttress-enclosed area. Ova in a clutch of 3 measured 6.0 × 8.8 to 6.0 × 9.0 mm. The other clutches consisted of 2 ova each, both 6.0 × 9.0 in one and 5.8 × 8.7 and 6.0 × 8.7 in the other.

Ristella travancorica (Beddome)

Ateuchosaurus travancoricus (part) Beddome, 1870, Madras Jour. Med. Sci., 1870, p. 33 — Western Ghats.

Ristella travancorica Beddome, 1871, Madras Jour. Med. Sci., 1871, p. 402; Smith, 1935, Fauna Brit. India, Rept., 2 : 331.

Material. 41 specimens : 20 females 31-37 mm SV, mean 34.4; 9 males 33-37 mm, mean 34.8; 2 hatchlings 16 mm, 10 juveniles 19-28 mm. One adult male had a complete, original tail 1.57 times SV and two females 1.29 and 1.43 times SV. Scale rows 22 (1) and 24 (10). Ventrals 48-54, mean 50.6 (n=10).

These have the diagnostic characters that distinguish *travancorica* from the similar species, *R. rurki* (Boulenger 1887, Smith 1935): dorsals with two sharp keels, scale rows 24 or less, posterior loreal single.

Ecological Notes. Three females were gravid; each contained 2 shelled ova. A pair of eggs measuring 5.33 × 11.0 and 5.5 × 11.2 mm were found under a rock (25 cm); one was kept in dead leaves for 23 days before preserving, at which time the embryo was near term. A second pair of eggs, also found under a rock, hatched in the field laboratory.

All individuals were found in evergreen forests, only 5 below 500 m and 31 between 860 and 950 m above sea level. Three-fourths were caught under dead leaves (21) or rocks (11), 5 on bare soil, and 1 low (0.3 m) on a tree trunk. The last may have been disturbed by one of us from its usual floor habitat before we saw it.

Sphenomorphus dussumieri (Duméril & Bibron)

Lygosoma dussumieri Duméril & Bibron, 1839, Erp. Gén., 5 : 725 — Malabar; Smith, 1935, Fauna Brit. India, Rept., 2 : 286.

Sphenomorphus dussumieri Taylor, 1950, Univ. Kansas Sci. Bull., 33 : 497.

Material. 34 specimens: 17 juveniles 22-32 mm SV; 1 subadult 43 mm; 8 females 49-60 mm, mean 55.5; 8 males 52-64 mm, mean 58.3. Tail 1.72-1.81 times SV (n=5, males only). Scales rows 38 (2), 40 (7), 41 (1), 42 (2). Ventrals 73-85, mean 80.5 (n=10). Scales under fourth toe 20-24, mean 21.8 (n=10).

Ecological Notes. Females had either 3 (4 individuals) or 4 (3 individuals) developing ova.

Lizards were caught in evergreen forest (14), moist-deciduous forest (8), secondary growth (8), and in a rubber planting (4). Most (21) were captured at 110-150 m above sea level and the remainder between 265 and 350 m. Annandale (1909a) found *dussumieri* at the base of the hills in Travancore.

Typhlops beddomi Boulenger

Typhlops beddomi Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 237 — hills of South India; Smith, 1943, Fauna Brit. India, Rept., 3 : 54.

Material. 1 specimen total length 90 mm. Scale rows 18. Transverse rows of scales 203. All of the head scales, starting two scales behind the eyes, are almost entirely covered with small glandules. Above dark brown; each scale edged anteriorly with a purplish brown streak. Snout and ventral surface lighter tan.

Ecological Notes. This snake was found in a patch of gallery forest at 950 m elevation beneath a rock (diameter 50 cm).

Typhlops braminus (Daudin)

Eryx braminus Daudin, 1803, Hist. Nat. Rept., 7 : 279 — Vizagapatam, India.

Typhlops braminus Cuvier, 1829, Reg. Anim., ed. 2, 2: 73; Smith, 1943, Fauna Brit. India, Rept., 3 :46.

Material. 1 specimen total length 145 mm. Scale rows 20. Transverse rows of scales 315. Glands of head scales as figured by Smith (1943, fig. 14).

Ecological Notes. This specimen was col-

lected beneath the bark of a 60 cm log in evergreen forest at 110 m elevation.

Uropeltis ceylanicus Cuvier

Uropeltis ceylanicus Cuvier, 1829, Reg. Anim., ed., 2, 2 : 76 — Ceylon; Smith, 1943, Fauna Brit. India, Rept., 3 : 80.

Material. 1 specimen total length 405 mm. Scale rows at mid-body 17. Ventrals 128; caudals 9.

Ecological Notes. This snake was found dead on a road through a tea plantation at 500 m above sea level.

Amphiesma beddomi (Günther)

Tropidonotus beddomei Günther, 1864, Rept. Brit. India, p. 269, pl. 22, fig. E — Nilgiris.

Amphiesma beddomei Malnate, 1960, Proc. Acad. Nat. Sci. Philadelphia, 112 : 50.

Natrix beddomei Smith, 1943, Fauna Brit. India, Rept., 3 : 306.

Material. 2 males total length 340, 500 mm, SV 250, 365 mm; 2 females total length 390, 565 mm, SV 300, 420 mm; 3 juveniles total length 150-180 mm, SV 115-130 mm. Eight supralabials. Temporals 1+1 (1), 1+2 (6). Scale rows at mid-body 19. Ventrals 136-140 (n=4); caudals male 76, female 61, 2 juveniles 68-73.

This sample exhibits the striking change in coloration with age described by Smith (1943).

Ecological Notes. All these snakes were found in evergreen forest well away from streams. Six were caught between 310 and 360 m above sea level and one at 950 m. Three individuals were found on or under dead leaves, 3 on the surface of the soil and the single high altitude snake under a 12 cm log. Two juveniles contained one small toad each (prey SV 10 mm) in their stomachs.

Xenochrophis piscator (Schneider)

Hydrus piscator Schneider, 1799, Hist. Amph., 1 : 247 — East Indies.

Xenochrophis piscator Malnate & Minton, 1965, Proc. Acad. Nat. Sci. Philadelphia, 117 : 19.

Natrix piscator Smith, 1943, Fauna Brit. India, Rept., 3 : 293.

Material. 1 male total length 475 mm, SV 335; 4 females total length 210-300 mm, SV 155-225 mm. Nine supralabials (4) or 9/10 (1). Temporals 2+2 (3), 2+1/2, 2+2/3. Scale rows at mid-body 19. Ventrals 129 (male), 142 (1 female); caudals 76 (male), 74 (1 female).

The small specimens are dark brown dorsally, grading to light tan laterally, with black vertical bars each covering 3-4 scale rows in 4 or 5 alternating rows across the entire body. The adult male is uniform olive brown except for black bars on the lateral scale rows.

Taxonomic Notes. Smith (1943) described four races of this common Asian water snake. However, the juvenile and adult color patterns of these specimens straddle two of his forms.

Ecological Notes. We collected 3 individuals from permanent small streams (1-4 m wide) between 105 and 350 m above sea level in clearings of moist-deciduous and evergreen forest, a fourth in a temporary pool in secondary growth at 350 m, and the fifth crossing a road at 500 m. In addition, several were seen, but not collected, foraging at night around a dammed pool (*c* 6 m diameter) in secondary growth at 800 m.

Elaphe helena (Daudin)

Coluber helena Daudin, 1803, Hist. Nat. Rept., 6 : 277 — Vizagapatam, India.

Elaphe helena Shaw *et al.*, 1939, Jour. Darjeeling Nat. Hist. Soc., 14 : 78; Smith, 1943, Fauna Brit. India, Rept., 3 : 149.

Material. 1 juvenile total length 395 mm, SV 325 mm. Nine supralabials. Scale rows at mid-body 25. Ventrals 243, caudals 74.

Color brown with dark crossbands containing white ocelli. Ventrally with semi-circular black bands extending about one-fourth width of ventrals, giving a scalloped black edge to the yellow-tan belly. A white nuchal

collar, interrupted along the midline and surrounded by black bands.

According to Smith (1943) this nuchal pattern is confined to populations from the Western Ghats.

Ecological Notes. This specimen was collected at 8 a.m. at 800 m on a road.

Oligodon affinis Günther

Oligodon affinis Günther, 1862, Ann. Mag. Nat. Hist., (3), 9 : 58 — Anamallais; Smith, 1943, Fauna Brit. India, Rept., 3 : 230.

Material. 1 juvenile total length 245 mm, SV 225 mm. Six supralabials. Scale rows at mid-body 17. Ventrals 140; caudals 20. No loreal. Posterior nasal elongate.

Color brown with dark brown crossbars edged with white. Below white with more or less alternating black squares. Head with complex dark pattern as in Smith (1943, fig. 79).

This specimen differs from Smith's (1943) description in having one less supralabial and fewer caudals (23 lowest count given by Smith).

Ecological Notes. Our snake was collected on a streamside rock at the edge of a village at 100 m above sea level.

Lycodon travancoricus (Beddome)

Cercaspis travancoricus Beddome, 1870, Madras Monthly Jour. Med. Sci., 2 : 169 — Travancore hills, India.

Lycodon travancoricus Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 293; Smith, 1943, Fauna Brit. India, Rept., 3 : 259.

Material. 1 male total length 545 mm, SV 430 mm; 1 female total length 525 mm, SV 420 mm. Nine supralabials. Scale rows at mid-body 17. Ventrals 166 (male), 180 (female); caudals 68 (male), 63 (female). All caudals in the male single, the first 40 single in the female. Dorsal coloration purple-black with white crossbars.

Ecological Notes. Both snakes were caught the same night along on a trail in evergreen forest at 310 m within a 30-minute interval. A steady rain was falling that evening.

Xylophis stenorhynchus (Günther)

Geophis stenorhynchus Günther, 1875, Proc. Zool. Soc. London, 1875 : 230 — Travancore.

Xylophis stenorhynchus Boulenger, 1890, Fauna Brit. India, Rept. Batr., p. 304; Smith, 1943, Fauna Brit. India, Rept., 3 : 343.

Material. 1 male total length 115 mm, SV 100 mm; 1 female total length 135 mm, SV 125 mm. Five supralabials. Scale rows at mid-body 15. Ventrals 102 (male), 119 (female); caudals 19 (male), 14 (female).

Dorsally dark brown with an irridescent sheen. Two lines of dark tipped scales on rows 2 and 4; a more or less well defined line of dark brown scales on row 3. A whitish collar 1-2 scales wide around entire neck. One snake has a distinct white temporal stripe.

Ecological Notes. Both specimens were collected in evergreen forest at 145 and 300 m above sea level under dead leaves. One was in the accumulated litter between buttresses of a tree 60 cm in diameter.

Ahaetulla nasuta (Lacépède)

Coluber nasutus Lacépède, 1789, Hist. Nat. Serp., 1 : 100 — Ceylon.

Ahaetulla nasuta Stejneger, 1933, Copeia, 1933 : 203.

Dryophis nasutus, Smith, 1935, Fauna Brit. India, Rept., 3 : 376.

Material. 3 males total length 650-1060 mm, SV 415-665 mm, mean 512 mm; 9 females total length 440-1330 mm, SV 290-870 mm, mean 611 mm. Eight supralabials, 1 snake with 9 on one side. Temporals variable, 1-2 anterior, 1-3 posterior, frequent asymmetries within individuals. Scale rows at mid-body 15. Ventrals in males 179-185, mean 181.6; in females 163-181, mean 176.1. Caudals in males 162-168, mean 165.6; in females 147-159, mean 153.4. Loreal present in only one snake.

In life brilliant grassy green above, paler

green below. A yellow line along the outer edge of the ventrals on each side extending to the vent. Smith (1943) lists several variants from this color pattern, none of which is represented in our sample.

Ecological Notes. A diurnal snake, 10 of 12 being caught during the day. Two individuals were found on exposed soil, one on a log, and one in a large tree 2 m above the ground in low branches. The remainder were taken from low shrubs, 2-2.5 m above the ground. One specimen was caught in secondary growth at 840 m above sea level; the rest were collected in evergreen forest (9) or in moist deciduous forest (2) between 145 and 350 m.

Boiga ceylonensis (Günther) (Plate VII)

Dipsadomorphus ceylonensis Günther, 1858, Cat. Col. Snakes Brit. Mus., p. 176 — Ceylon.

Boiga ceylonensis Smith, 1943. Fauna Brit. India. Rept., 3 : 351.

Material. 2 males, total lengths 755, 940 mm, SV 585, 725 mm; 1 juvenile total length 495 mm, SV 385 mm. Supralabials 8. Temporals 2+3. Scale rows at mid-body 19. Ventrals in males 228, 233; 218 in juvenile. Caudals in males 108, 112; in juvenile 102. Hemipenis covered with numerous short, closely set spines.

Color pattern of the head in all three specimens consisting of a light tan background with dark brown, symmetrical markings. A transverse bar along the posterior edge of each parietal, met on the midline by a longitudinal mid-dorsal streak extending posteriorly from the parietals 5-7 scales. A thin postorbital streak from the eye beyond the angle of the jaw immediately above the supralabials. A pair of dark chevrons more or less developed on the anterior margin of the parietals. Body covered dorsally with alternating dark and light blotches, producing a diffuse banded pattern. Ventrally white with irregular dark brown flecks.

Taxonomic Notes. We here use *B. ceylonensis* in the restricted sense of Wall (1909), as opposed to the extended sense of Smith (1943), and consider at least *B. ceylonensis* and *B. nuchalis* to be valid species. *B. nuchalis* is discussed on p. 568.

Ecological Notes. Two specimens were collected at 310 m in evergreen forest, one on the soil surface and the other 60 cm above the ground in a low shrub. The third snake was taken in the early morning crossing a road at approximately 800 m above sea level.

Boiga dightoni (Boulenger)

Dipsas dightoni Boulenger, 1894, J. Bombay nat. Hist. Soc., 8 : 528 — Pirmaad, Travancore.

Boiga dightoni Smith, 1943, Fauna Brit. India, Rept., 3 : 359.

Material. 1 male total length 1170 mm, SV 920 mm; 1 female total length 965 mm, SV 770 mm. Female missing the tip of the tail. Eight supralabials. Scale rows at mid-body 23. Ventrals 248 and 239, caudals 111 and 90 in the male and female, respectively.

Above uniform light brown; supralabials tan with fine dark brown specks. Below light tan with dark brown flecks. The scale counts for the male is somewhat higher than the range given by Smith (1943 : ventrals 228-241, caudals 95-102). However, as Smith had only 3 specimens available, his ranges should be considered approximate. In all other characters our material agrees well with Smith's description.

This is a rare species in collections, with apparently only 3 specimens known other than the two reported here.

Ecological Notes. Both snakes were taken in secondary growth situations at high altitudes (700 and 840 m). The male was caught 1.3 m above ground in a small shrub at night

and contained a partially digested *Calotes versicolor* (SV 95 mm, total length 320 mm) swallowed head first.

Boiga nuchalis (Günther) (Plate VII)

Dipsas nuchalis Günther, 1875, Proc. Zool. Soc. London, 1875 : 233 — west coast of India.

Boiga ceylonensis (part) Smith, 1943, Fauna Brit. India, Rept., 3 : 351.

Material. 2 males total length 705, 1155 mm, SV 560, 895 mm. Eight supralabials. Temporals 2+3. Scale rows at mid-body 23. Ventrals 248, 249; caudals 107, 108. Head elongate, snout blunt, eyes not protruding.

Head dark tan with a faint darker brown triangular patch extending from the posterior border of the parietals anteriorly over the head to the rostral. A nuchal collar of dark brown separated from the large dark patch by 2-3 scales. The collar is 3 scales wide in both specimens. A sharply defined dark streak from the posterior border of the eye to the last supralabial. Pattern of the body similar to that of *B. ceylonensis*, consisting of alternating crossbands of dark brown on a tan background. Ventrally light with brown flecks.

Taxonomic Notes. There has been disagreement in the literature concerning the validity of this form as a species distinct from *B. ceylonensis*. Wall (1909) divided *B. ceylonensis* into four species (*andamanensis, beddomi, ceylonensis,* and *nuchalis*) on the basis of ventral, subcaudal, and mid-body scale counts. Annandale (1909b) disagreed with Wall's judgement and Smith (1943) lists all 4 under *ceylonensis,* primarily because he could find no additional characters corroborating the scale count differences. We observe a difference in coloration; compare descriptions presented here.

Ecological Notes. Both specimens were caught at night, one on the ground in a large clearing and the other on a road at 200 m elevation.

Hypnale hypnale (Merrem) (Plate VIII)

Cophias hypnale Merrem, 1820, Syst. Amph., p. 155-"Levante."

Hypnale hypnale Gloyd, 1977, Proc. Biol. Soc. Washington, 90: 1009.

Ancistrodon hypnale Smith, 1943, Fauna Brit. India, Rept., 3: 499.

Material. 4 males total length 276-340 mm, SV 234-289 mm, mean 260.5 mm; 7 females total length 353-412 mm, SV 314-360 mm, mean 335.4 mm; 1 juvenile SV 132 mm. Seven supralabials. Scale rows at mid-body 17. Ventrals in males 135-141, mean 137.8; in females 133-141, mean 138.0. Caudals in males 40-42, mean 40.8; in females 33-35, mean 34.0.

Ecological Notes. Eight of the 12 in this sample were caught in evergreen forest, 3 in moist-deciduous forest, and 1 in secondary growth. Three were on rocks, one on a log, and the rest at ground level on soil or dead leaves. Altitudinal range was narrow, 105-350 m. One female (SV 354 mm) had a small mammal in the gut. Another (SV 340 mm) contained 5 near term embryos.

Trimeresurus malabaricus (Jerdon)

Trigonocephalus malabaricus Jerdon, 1854, Jour. Asiatic Soc. Bengal, 22: 523—Western Ghats.

Trimeresurus malabaricus Smith, 1943, Fauna Brit. India, Rept., 3: 513.

Material. 13 males total length 340-550 mm, SV 285-450 mm, mean 388 mm; 13 females total length 275-665 mm, SV 230-565 mm, mean 354 mm; 14 juveniles total length 185-285 mm, SV 155-240 mm. Supraoculars 1-5, variable between sides. Internasals 2-3 times size of adjacent scales and meeting in midline. Scale rows at mid-body 21 (38) or 23 (2). Ventrals in males 143-150, in females 138-146, in juveniles 135-152. Caudals in males 53-58, in females 51-59, in juveniles 48-60.

Coloration variable. Larger individuals

Hypnale hypnale.

(> 420 mm total length) dark brown with irregular green crossbars. In some specimens green predominates, with black saddles across the back. Head dark with scattered light green scales. Below mottled green and yellow; a few of the scales in the lowest lateral row sometimes yellow. Tail above brightly banded with green and black, occasionally with some yellow. Juveniles and a few of the adults light brown above with a series of dark brown, diamond-shaped saddles distinct or barely visible. In a few a second series of smaller brown spots on the first scale row bordering the caudals.

The two color phases in our sample are very similar to Smith's (1943) descriptions of the color patterns of *T. malabaricus* (greenish) and *T. strigatus* (brownish), both from the southern Western Ghats. However, the scale counts and condition of the second supralabial (very long and forming the anterior portion of the loreal pit) agree with *T. malabaricus* regardless of coloration. Several of our intermediate-sized animals appear to be in transition between the two color forms; that is, they retain the overall brown saddled pattern but are becoming very dark, and the tail is assuming the green color.

Ecological Notes. Three snakes were caught in moist-deciduous forest, 35 in evergreen forest, and 2 in gallery forest extending into grassland from a block of evergreen forest. Altitudinal range was extensive, 110-920 m, although most (28) were found in the 300-375 m zone. Seven snakes were captured along water courses, 32 at some distance from streams, and one in a large clearing. About half (21) were found at the ground level, on dead leaves, rocks, and logs, and the remainder on herbaceous plants, shrubs, stumps, and trees from 0.1 to 3.0 m above the ground.

Only 4 of these snakes contained food remains. One juvenile (SV 240 mm) had an adult *Cnemaspis tropidogaster* (SV 32 mm) and another (SV 225 mm) had a *Rhacophorus* (probably *R. pleurostictus*, SV 31 mm). An adult female (SV 545 mm) had recently ingested a musk shrew (*Suncus murinus*, body length 120 mm), and another female (SV 565 mm) had mammal hair in its gut.

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POLLINATION ECOLOGY OF *EUPHORBIA GENICULATA* (EUPHORBIACEAE)[1]

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(*With a plate & three text-figures*)

Euphorbia geniculata is monoecious and reproduces both by geitonogamy and xenogamy. The stigmas are fully receptive by the 3rd day of anthesis, and the male phase is evident from the 5th day of female anthesis, with the anthers dehiscing between 0800-1000 h. The nectar is glucose + fructose dominant type, and is secreted in quantity by day and night. The cyathium is flat blossom and is of the promiscous type. Pollination is effected by a broad spectrum of diurnal insects and is of the 'mess and soil' type. The principal pollinators are ants (*Camponotus*), wasps (*Ropalidia, Polistes, Vespa*) and beetles (*Coccinella*). The ants are consistent and more abundant, and they alone could satisfy the pollination requirement to result in 100% reproductive success. The ants because of their crawling behaviour mainly deliver geitonogamous pollen, but their bellicose nature helps the plant to achieve more outcrossing by the wasps which being scared of the ants move more often from plant to plant.

Introduction

In the family Euphorbiaceæ, the genus *Euphorbia* is the largest one represented by more than 1600 species (Lawrence 1973), all of which are almost cosmopolitan in distribution, but majority confined to the tropics (Kerner 1904, Good 1964). The cyathial morphology and anatomy were fully studied by several generations of botanists since Roeper's day and the basic structure is now well understood; however, this knowledge has never been related effectively to pollination problems (Webster 1967).

The early works reported diverse groups of insects visiting 18 species of *Euphorbia* (Knuth 1906-9); however the importance of insects in the reproductive biology of these plants remained obscure. Only very recently has there been a detailed study by Ehrenfeld (1976, 1979) in respect of three species of *Euphorbia*, sub-genus *Chamaesyce*. His results showed that the three species differ in their reliance on insect vectors for reproduction. Despite such scattered observations, the floral biology of the genus *Euphorbia* characterised by unique floral device is still rather poorly known (Webster 1967, Ehrenfeld 1976). Realising the importance and dearth of these studies from the tropical zones, especially of the Indian subcontinent, attempts were made to collect the data on pollination ecology of *Euphorbia geniculata*, a monoecious annual weed occurring in the cultivated fields and gardens, and growing to 1 m height.

Materials and Methods

Euphorbia geniculata Orteg. (*E. heterophylla* L.) growing at Visakhapatnam in the cultivable lands of the Botany Experimental

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Farm area 3 km away from the Andhra University Campus on NH5 formed the material for the present study. Fifty cyathia labelled in bud condition were followed till they ceased to produce flowers to record daily anthesis from which the male to female flower ratio was computed. Numerical assessment of the pollen grains contained in an anther was made squashing the mature and undehisced anther in lactophenol aniline-blue and counting the entire pollen mass drawn into a band on the microscope slide. Periodic determinations of the pollen contained in the dehisced anthers were similarly done. The pollen grains deposited on the stigmas were counted after pressing the stigmas in between two glass slides. The longevity of pollen was assessed through *in vitro* germination studies using 20% sucrose solution with 1% boric acid solution added. The length of the stigma receptivity was based on pollen germination after hand pollinating the stigmas of different ages.

To monitor the nectar amounts, the plants in bloom were covered with insect proof cages for the required periods and DDT was applied around the plants to prevent the ants reaching the nectar cups. The nectar accumulated in the cups was measured at intervals using dispensable micropipettes. Sugar concentration was read with Erma Hand Refractometer and sugar composition using paper chromatography and spectrophotometry (Harborne 1973). Proteins and amino acids were detected according to Baker & Baker (1973).

The insects caught at the cyathia all through the study period (1979 and 1980) were got identified through the courtesy of CIE London. Green house was used to study the prevailing breeding system(s) and to estimate the reliance on insects for pollination. Sticky cylinders were exposed daily for a week at the plants' height to assess the role of wind in pollen dispersal. To assess the efficacy of ants *versus* other foragers as pollinators, certain plants were allowed to receive the foragers excluding the ants through applying DDT at the plant bases. Another batch of plants were open to ant visits only. After leaving sufficient time, the fruits and the seeds formed, were scored and compared.

The number of cyathia visited in a bout and per unit time, and the time spent on a cyathium by each major insect species were recorded using a stop watch. The more frequent visitors were caught at the cyathia and were washed with alcohol. After adding a droplet of lactophenol aniline-blue, these washings were observed for pollen under light microscope. To determine the number of pollen that could be transferred on to the stigmas by a single visit of a particular kind of insect visitor, plants in bloom kept in insect-free cages were opened in batches for the insects to visit; when such exposed cyathia received the first visit they were plucked and their stigmas examined for pollen. Several such observations were done and the mean number of pollen transferred, was calculated.

Observations

Floral dynamics

The plants are evident in any part of the year provided the soil contains enough moisture. Normally, these appear after the first rains. After a month's vegetative growth, the plants bloom, the blooming normally lasting for $1\frac{1}{2}$ to 2 months.

Inflorescence. It is a cyathium. Several such cyathia (45 ± 18) are arranged in terminal condensed dichasia of 3.5-4.0 cm in diameter. Cyathium is glabrous without and consists of an ovoid involucre with the margin lined with a fringe of fleshy, finger-like lobes. A con-

TABLE 1

RATE OF ANTHER DEHISCENCE IN *E. geniculata* ON FOUR DIFFERENT OCCASIONS IN RELATION TO THE PREVAILING WEATHER

Time (h)	8-5-1979			11-5-1979			12-5-1979			16-5-1979		
	i	ii	iii	i	ii	iii	i	ii	iii	i	ii	iii
0600	27.0	85	0	27.0	90	0	27.0	90	0	27.0	81	0
0700	28.0	83	0	27.0	90	0	27.0	90	0	27.3	80	0
0800	28.5	80	0	26.5	95	0	27.7	88	0	27.5	79	75
0900	33.2	70	75	28.2	90	0	27.5	88	0	28.5	75	25
1000	34.0	65	25	28.5	90	0	28.0	85	0			
1100				31.1	70	21	28.0	85	0			
1200				31.8	68	4	28.0	83	0			
1300				30.0	80	6	28.0	80	0			
1400				29.5	77	0	28.0	82	0			
1500				27.0	80	0	28.0	85	0			
1600				27.0	80	0	28.2	83	0			
1700				27.0	80	0	28.2	84	0			
1800				27.0	80	0	28.2	83	0			
	Partly cloudy sky			Rain intermittent			Rain continuous			Clear sky		

i = Temperature (°C); ii = Relative humidity (%), iii = No. of dehisced anthers Sample size = 100 male flowers.

spicuous, fleshy, terete, stipitate gland with slightly flared round opening is situated on the involucre to a side. In rare cases 2-4 such glands are noticed.

Each cyathium is normally bisexual, but occasionally the female part is suppressed. Out of the 550 cyathia examined, 85% bore both female and male flowers, whereas 15% consisted of only male flowers.

Staminate flowers. Several male flowers surrounding the female are located within the involucre. They also lack perianth and each one is monandrous with the subglobose, 2-lobed anthers being borne on a pedicel of 3 mm long. The male phase of the cyathium is evident from the 5th day of female anthesis. The anther starts getting exserted above the rim of the cyathium from 0600 h and is fully exserted by 0800 h. Anther dehiscence is accomplished by the horizontal fissure on the side of the anther facing upwards, when the

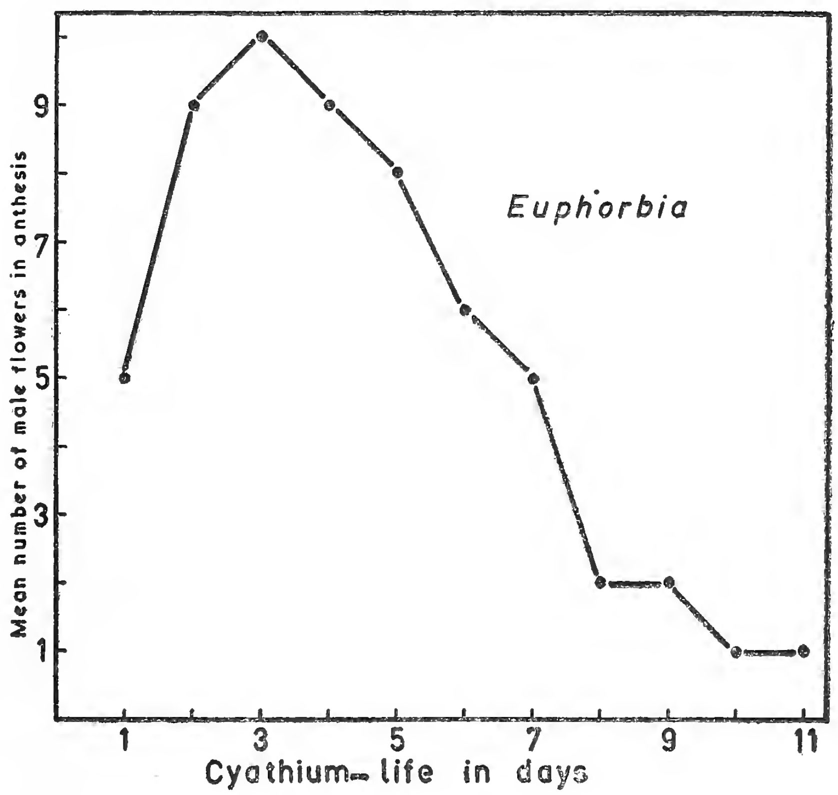


Fig. 1. Day to day anthesis of male flowers in the life-time of the cyathium of *Euphorbia geniculata.*

ambient temperature approaches 28-32°C and RH 70-75% (Table 1). If the conditions are wet as on a rainy day, the process is suppressed and the anthers being ephemeral drop away the next morning.

Each day varying numbers of male flowers attain maturity (Fig. 1) and over the entire period (8±2, R.6-11 days) of male phase, 55±11 (R. 39-68) flowers emerge out.

Pollen morphology. The pollen grains are subspheroidal, tricolporate, 56±5 μm (R. 48-64) with the modal class of 56 μm, and the exine is reticulate.

Pollen supply. The number of grains per male flower varied between 276-445, the average being 370±42 (n=20).

Pollen viability. About 12% of the pollen per male flower are sterile as evidenced by their abnormal size, shape and poor stainability with lactophenol aniline-blue.

Germ tube initiation occurred after 15 min. of placing the grains in the medium; the tubes burst after 3 hrs. On an average 88% of the freshly collected pollen germinated. The same sample of pollen showed 80% germination after 24 hours of storage in the laboratory. The germination per cent fell drastically after 48 hours, and after 72 hours there is none.

Pistillate flowers. Each cyathium bears a solitary and centrally located female flower lacking perianth. A 3-celled ovary with a single ovule in each cell, is supported on a rather prominent stalk. Styles are 3, connate at the base; each stigma is bifid.

Maturation of the female flower. Figure 2 represents the different stages in the maturation of the female flower. The exsertion of the stylar column above the rim of the cyathium

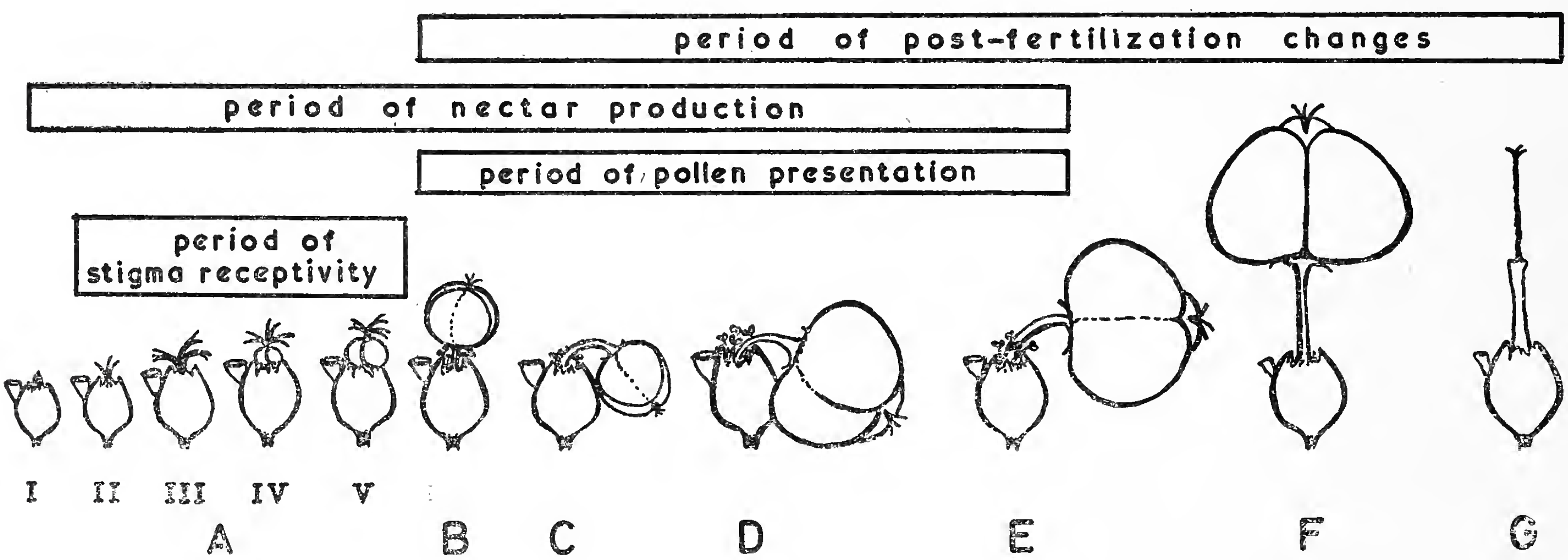


Fig. 2. Pictorial representation of the different reproductive phases in a cyathium of *Euphorbia geniculata*: A — Female phase with the stigma in various maturation stages (I — stigma exserting, II — stigma tripartite and shiny, III — stigma well developed, reflexed and shiny, IV — ovary partly exserted and the stigma shiny, V — ovary fully exserted and the stigma shiny); B — Male phase commenced and the ovary (fruit) stalk started reflexing; C & D — Ovary stalk fully reflexed and the anthers are freely exposed; E — Male phase ceased and the ovary stalk is in the process of resuming its original erect posture; F — Ovary stalk has regained its original erect posture and the nectar cup is in the shrunken state; G — the stalk after the dehiscence of the fruit.

marks the beginning of anthesis. It occurs in the morning after sunrise, but may vary with the age of the flower. By this time traces of nectar are detectable in the nectar cup, though it continues enlarging. By next morning the stylar column becomes tripartite and the branches start diverging and the stigmas become bifid and begin reflexing. They are slightly sticky. By the 3rd day of anthesis, the stigmas are reflexed and fully receptive. They remain in this condition for another two days. By this time the ovary is pushed out of the cyathium because of the elongation of the pedicel. The pedicel reflexes so that the ovary rests on the outside of the involucre on the side just opposite to the position of the gland; the stigmas wither and are unreceptive. The pedicel further elongates and by the 8th day of female anthesis, the ovary almost assumes an inverted position. Later it regains its original erect posture before dispersing the seeds in an explosive way.

These movements are obviously designed to give sufficient room to the anthers when they are exserted, in order that they inevitably gain contact when a proper visitor alights on the cyathium.

Pollen-Ovule ratio. On an average 7980 grains are produced to meet the demands of one ovule. Out of these only 0.223% reaches the stigma.

DYNAMICS OF NECTAR

Nectar amounts and pattern of production. Measureable amounts of nectar are produced from the 2nd day after the stigma attains receptivity and continue to be produced till the cessation of the male phase. Nectar is secreted both by day and night. On an average a cup produces 19.23 μl of nectar in its lifespan. The rate of secretion increases up to the 4th day and thence decreases till the 13th day when it ceases. The amounts secreted during the nights are comparatively more, probably because of low evaporation taking place. There is no appreciable trend in the rate of secretion, it being uniform at different times during daytime. However, the pooled up amounts exceeded the quantity removed after the entire period (Table 2).

Nectar concentration. On a normal day the

TABLE 2

NECTAR VOLUMES OF REPEAT-SAMPLED VS. ONCE-SAMPLED CUPS IN *E. geniculata* AND THE ASSOCIATED WEATHER

2 hourly samples				Sample for 12 hours
Time (h)	Temp. (°C)	RH (%)	Mean nectar volume (μl)	Mean nectar volume (μl)
0600-0800	29.4	83	0.470	
0800-1000	30.3	79	0.470	
1000-1200	32.1	68	0.460	
1200-1400	32.0	68	0.455	
1400-1600	31.8	70	0.465	
1600-1800	30.8	70	0.470	
0600-1800				2.225
Total volume			2.790	2.225
			n = 20	n = 20

TABLE 3

TEMPORAL VARIATION IN *E. geniculata* NECTAR CONCENTRATION AND THE ASSOCIATED WEATHER

Time (h)	Concentration (%)	Temperature (°C)	RH (%)
0600	25	23.8	79.0
0900	27	24.8	69.5
1200	30	26.7	67.0
1500	32	26.9	60.0
1800	29	25.0	70.0

TABLE 4

FLORAL VISITORS ON *E. geniculata*

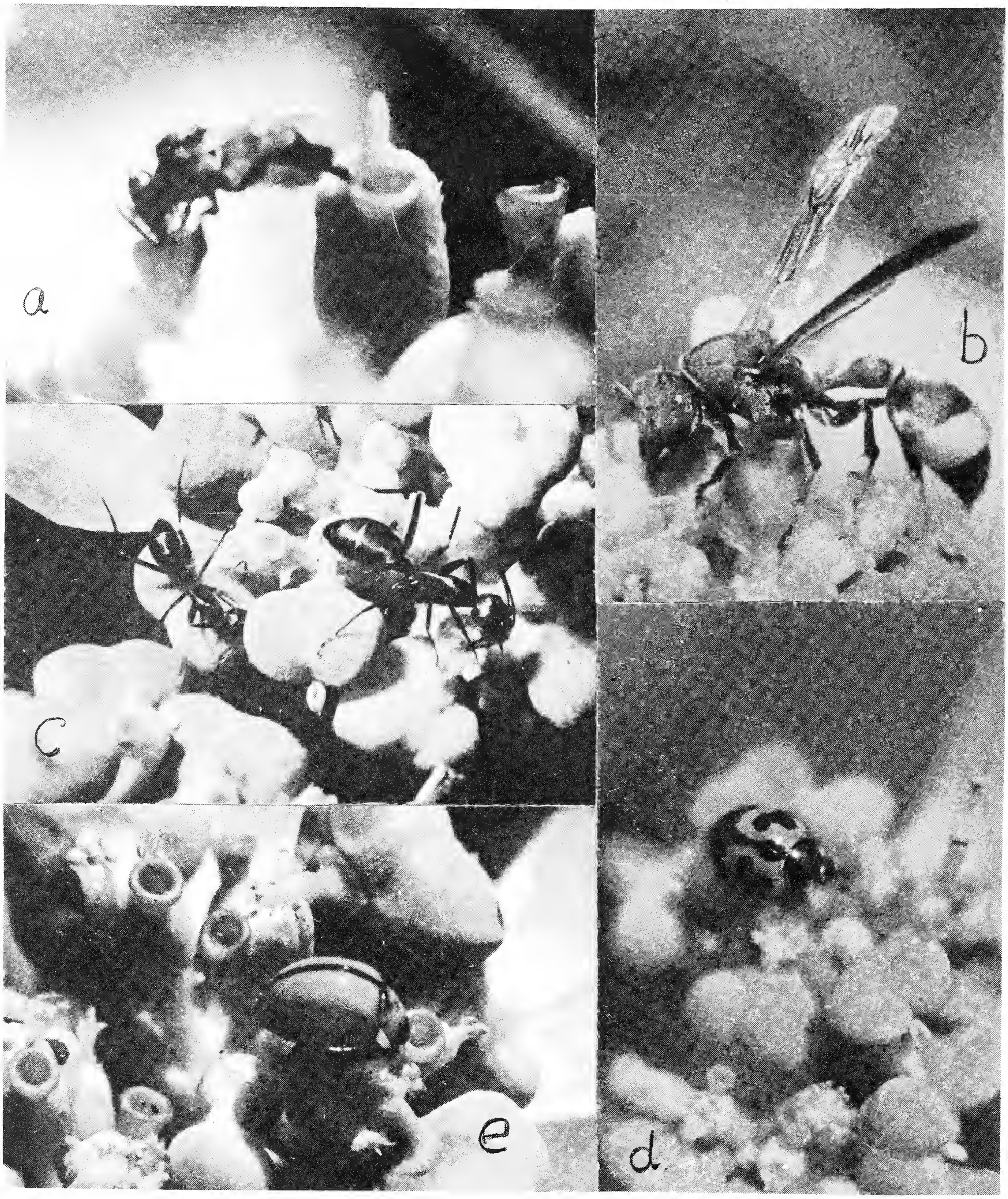
Insect species	Forage type
HETEROPTERA	
Lygaeidae	
Geocoris ochropterus (Fieber)	Nectar
COLEOPTERA	
Coccinellidae	
Coccinella rependa (Thunberg)	Nectar & anthers
Verania discolor (F.)	Nectar & anthers
V. vincta (Gorham)	Nectar & anthers
Menochilus sexmaculatus (F.)	Nectar
Nitidulidae	
Macroura sp.	Nectar
Bruchidae	
Spermophagus sp.	Nectar
Curculionidae	
Baris dolosa (Mshl.)	Nectar
DIPTERA	
Asilidae	
Laxenecera sp.	Nectar
Bombyliidae	
Eucharimyia sp.	Nectar
Syrphidae	
Eristalinus quinquestriatus (F.)	Nectar
Otitidae	
Physiphora sp.	Nectar
Chloropidae	
Anatrichus pygmaeus (Lamb)	Nectar
Muscidae	
Musca pattoni (Austen)	Nectar
Calliphoridae	
Rhyncomya viridaurea (Wiedemann)	Nectar
Chrysomya megacephala (F.)	Nectar
HYMENOPTERA	
Formicidae	
Camponotus sericeus (F.)	Nectar
Camponotus sp.	Nectar
Solenopsis geminata (F.)	Nectar
Paratrechina sp.	Nectar
Sphecidae	
Chalybion bengalense (Dahlbom)	Nectar
Vespidae	
Ropalidia spatulata (Vecht)	Nectar
Polistes stigma tamula (F.)	Nectar
Vespa sp.	Nectar
Apidae	
Trigona sp.	Nectar
Apis cerana indica (F.)	Nectar & Pollen
A. florea (F.)	Nectar & Pollen
ARANEAE	
Oxyopidae	
Oxyopes birmanicus (Thorell)	Predates mostly on flies
Thomisidae	Predates mostly on flies
Thomisus sp.	
Salticidae	
'Unidentified'	Predates mostly on flies

concentrations measured at 3-hourly intervals from 0600 to 1800 h (Table 3) show a gradual rise up to 1500 h, of course not to appreciably high levels, and thence a gradual fall. The lowest concentration recorded is 25% and the highest 32%.

Sugars in nectar. The sugars and their relative amounts per μl are glucose (0.11 mg), fructose (0.095 mg) and sucrose (0.025 mg). The nectar is glucose plus fructose dominated, with a ratio of glucose + fructose/sucrose of 8:2; it is characteristic of unprotected open nectaries (Percival 1961).

Aminoacids in nectar. They are present and the score on histidine scale is 6.

Proteins in nectar. A faint greenish blue colour with the bromo-phenol blue stain on



Photographs of insects at the cyathial clustures of *Euphorbia geniculata: a - Trigona* bee lapping on the nectar; b - wasp (*Ropalidia spatulata*) lapping on the nectar; c - ant (*Camponotus* sp.) taking the nectar; d - beetle (*Coccinella repanda*) taking the nectar; e - beetle (*Verana discolor*) taking the nectar.

the chromatographic paper with nectar drop dried, indicates the presence of proteins but in meagre amounts.

INSECTS ACTIVITY DYNAMICS

Composition. A list of the insect visitors in the population are available in flower during April-September. Table 5 gives the relative frequency of different foragers classed under the arbitrary groups: ants, wasps, beetles, bees, and others of rare occurrence in different months.

TABLE 5

SEASONAL VARIATION IN THE DIFFERENT GROUPS OF INSECT FORAGES AT *E. geniculata* FLOWERS

Sampling day	Ants	Wasps	Beetles	Bees (*Trigona*)	Total	Simultaneously blooming associated plant species
1979						
17 April	165	56	68	0	289	E, Pe, So.
17 May	142	96	10	0	248	A, B, E, Pe, Ph, So, Sor.
20 June	258	118	17	0	393	Am, B, C, E, J, La, Pe, Ph, So, T, Z.
23 July	225	121	0	0	346	Am, C, E, J, La, Le, Pe, Ph, So, T, Z.
29 August	123	37	0	0	160	Am, C, E, J, La, Le, Pe, Ph, So, T.
9 September	136	68	0	102	306	Am, C, E, La, Le, Ph, So, T.
1980						
7 June	249	127	33	0	409	Am, B, C, J, La, Pe, Ph, So, T.
5 July	232	77	28	0	337	Am, C, E, J, La, Le, Pe, Ph, So, T.
24 August	163	95	11	0	269	Am, C, E, J, La, Le, Ph, Sor, T.
21 September	124	86	14	136	360	C, E, La, Le, Pe, Ph, T.
29 December	95	22	68	0	185	B, C, E, La, Sa, T.

Am — *Ammonia baccifera*; Ar — *Arachis hypogea*; B — *Brassica nigra*; C — *Croton bonplandianum*; E — *Euphorbia hirta*; J — *Jatropha gossypiifolia*; La — *Lantana camara*; Le — *Leptadenia reticulata*; Pe — *Pennisetum typhoideum*; Ph — *Phyllanthus niruri;* Sa — *Sapindus emarginatus;* So — *Solanum nigrum*; Sor — *Sorghum vulgare*; Tr — *Tridax procumbens*; Z — *Zea mays.*

collected during the entire period of the study is furnished in Table 4, and those insects photographed at the cyathia are given in Plate I. Of the 30 species, 7 belong to Coleoptera, 11 to Hymenoptera, 8 to Diptera, 1 to Heteroptera, and 3 to Araneae; the activity of 27 of these is mainly directed to collection of nectar, the other three, not to be recognised as visitors in the sense of pollination ecology, are predators and simply await the arrival of their prey (mostly Dipterans) at the cyathia.

Seasonal periodicity. During 1979 the plants

Both ants and wasps visited the flowers throughout the blooming period, but in every month ants predominated. Beetles appeared from April and persisted only till June; their number in April exceeded those of the wasps, but thenceforth maintained at a lower level. Bees, mostly *Trigona* were only evident in September, and are next to ants in abundance.

In 1980, because of delayed onset of monsoon rains, the plants in flower were available from June onwards. Right then, ants, wasps, and beetles started visiting. As in 1979 ants frequented more. Beetles were less frequent all

through the period. In September as usual *Trigona* appeared in relatively large numbers. From October to November the plants were not available because of some weeding practices, but by December some were evident and ants, wasps and beetles were seen visiting them in considerable frequency.

It is surprising that *Apis* species which have been observed on most plant species of the Visakhapatnam flora are very rarely noticed at the flowers of *E. geniculata.* Why these honeybees shun *E. geniculata* flowers? Probably as reported by Deodikar *et al.* (1958), the forage of this plant may be poisonous to these bees; these authors reported an instance of large scale paralysis and deaths among bees due to their foraging on flowers of *E. geniculata.* However, Deodikar (1961) remarks that such plants may be visited due to acute hunger and starvation in times of acute shortage of normal forage during floral gap periods.

Diurnal periodicity. Figure 3 illustrates the activity pattern of different arbitrary groups of insects studied for half an hour at 1-hourly intervals in different months but represented as pooled up data. Though ants forage on nectar during the whole day, the activity pattern is measured only during daytime. Their activity from 0600 h gradually increased to a maximum by 1030 h and decreased slowly to lower levels up to 1330 h but again revived and kept on increasing till the end of observation period. The activity pattern of wasps and beetles is identical with each other. The number of visits rose to maximal levels between 0730-0830 h, and then declined rather gradually to minimal levels by 1330 h, but again the activity slightly resurged and continued till it ceased with the set in of dusk. *Trigona* bees were evident from 0700 h onwards till they disappeared with the set in of dusk. The activity increased rather slowly up to the 0830 h, but then showed a sharp rise to a maximum in the next hour; thence there was a gradual decline to lower levels up to 1200 h when again there was a resurgence increasing to a considerably higher level by 1630 h from then onwards the activity fell abruptly.

There is a clear indication of relationship of insect activity with the temperature. In general the activity kept on increasing in parallel with the temperature but up to certain temperature levels which varied with the different groups. Thus ant activity increased up to 1030-1130 h, when the ambient air tempera-

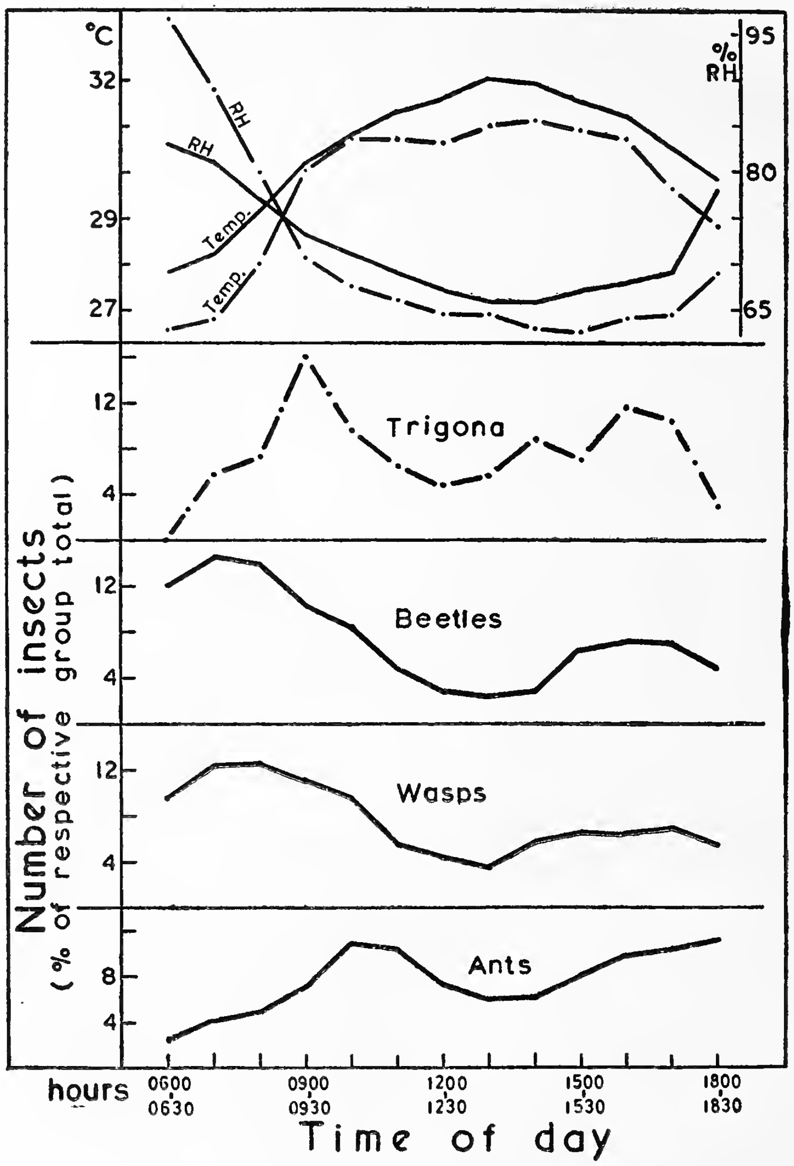


Fig. 3. Diurnal variation in the number of different insects visiting the cyathia of *Euphorbia geniculata* related to the prevailing temperature and relative humidity.

TABLE 6

TEMPORAL VARIATION IN POLLEN DEPLETION FROM ANTHERS VS. POLLEN DEPOSITION ONTO STIGMAS OF *E. geniculata* UNDER INSECT ACTIVITY

Time (h)	Mean No. of pollen depletion/ flower	Rate of pollen depletion (%)	Mean No. of pollen deposited onto stigma	Rate of pollen deposition (%)
0800	0	0	0	0
1000	174	47.0	18	41.9
1200	82	22.2	13	30.2
1400	35	9.5	5	11.6
1600	32	8.7	6	14.0
1800	14	3.8	1	2.3
	(n = 10)		(n = 20)	

tures were 30.8-31.3°C, wasp and beetle activity was brisk between 0730-0830 h when the air temperatures were 28.2-29.1°C, and *Trigona* activity increased up to 0930 h when the air temperature was 30.1°C. With further rise in temperature the activity tended to decline till 1330 h. From then onwards, it was revived with the downward trend in temperature. *Trigona* bees appear to dislike to work at high humidities, as they have not appeared before 0700 h when high humidities prevailed.

Pollen depletion v. pollen deposition on to the stigmas under insect activity. Predictably there is an inverse relationship between pollen depletion from the anthers and pollen deposition onto the stigmas (Table 6). Most pollen (69%) is removed by noon and 72% of the total stigmatic pollen loads is getting deposited by then.

Determinations of the pollen content of anthers dropped off the stamens revealed that *c.* 9% of the total pollen output may remain without removal by the insect activity.

Visits per unit time, and the time spent on cyathia per visit. As is obvious the time spent by a visitor on a cyathium is inversely related to the number of cyathia it visited per unit time (Table 7). Wasps are mobile spending *c.* 3 seconds on a cyathium and visiting 15 cyathia in a minute, followed by *Trigona,* ants, and beetles in that order.

Pollen pick up and pollen transfer onto the stigmas. The ability to transfer pollen onto the stigmas is directly related to the ability of a visitor to pick up pollen, both are a function of body size of the respective insects. Wasps being relatively larger in size picked up and moved more pollen than other groups; ants, *Trigona* and beetles follow wasps in that order (Table 7).

TABLE 7

DYNAMICS OF THE INSECT ACTIVITY ON *E. geniculata* FLOWERS

Insect variety	Mean No. of insect visits/ minute	Mean length of time at a flower in a visit (seconds)	Mean No. of pollen carried on insect bodies	Mean No. of pollen transferred per single visit	Time spent towards foraging/ minute (seconds)
Beetles	3	14	42	3	34
Ants	11	4	108	4	40
Wasps	15	3	231	6	42
Trigona	13	3	57	1	39
	n = 20	n = 50	n = 5	n = 10	

MODES OF REPRODUCTION

Table 8 represents the results of breeding experiments from which it is evident that the plants are compatible for both geitono- and xeno-gamous pollen with nearly 100% success. Apomixis is totally absent.

TABLE 8

FRUIT AND SEED SET, AND FECUNDITY IN DIFFERENT MODES OF REPRODUCTION IN *E. geniculata*

Treatment	No. of cyathia obser-ved	No. of cyathia set fruit	Fruit set (%)	Seed set (%)	Fecun-dity (%)
Apomixis (Emasculated and kept under insect exclo-sures)	475	0	0	0	0
Geitonogamy	77	75	97.4	97.4	97.0
Xenogamy	85	84	98.8	100.0	98.8
Open pollination	568	568	100.0	95.5	95.5
Under insect exclosures	496	65	13.0	47.8	6.7

DISCUSSION

The cyathium, though consists of many male flowers (each in the form of a single stamen) and one terminal female, is ecologically equivalent to a flat simple blossom (Knuth 1906-9). Such a floral device is very economical both to the plant and the animal visitor (Grant 1976). The Cyathia in *Euphorbia geniculata* are markedly protogynous, thus precluding pollination within a cyathium and also establishing a potential for outcrossing and the resultant genetic variability. In a cluster of cyathia, different staged ones are evident, such that on any day some cyathia would be in a female stage and some in a male stage.

Of the different groups of insect foragers at the cyathia (Table 4), ants, wasps, and beetles are treated as the effective pollinators in the light of the principles propounded by Free and Williams (1977). No doubt other insects included in the table also carry out some pollination.

The dehiscent side of the anthers is directed upwards, and when the insects concerned land in the cyathia and walk about, pollen is deposited sternotribically. Pollen pick-up by the insects in unhindered by the floral device involving the change in position of the pistil in the cyathia (Fig. 2). When the pollen laden insects land and move in the female cyathia they contact the stigmas and effect pollination which may be geitono- or xeno-gamous because the plants are adapted for both modes of reproduction. The cyathia have no closely evolved relationship with any of the pollinating insects, and thus function as a promiscuous floral device in attracting insects (Grant 1949), and relies on 'mess and soil' insect behaviour (Faegri & Pijl 1979) to be pollinated. As such, any insect with sufficient body size to permit contact with the anthers or the stigmas is capable of promoting pollination at least within the plant by its movement.

The major groups of insects associated with the cyathia of *E. geniculata* are similar to those encountered in related species of *Euphorbia.* (Knuth 1906-9, Kügler 1970, Proctor & Yeo 1975, Ehrenfeld 1979), but the individual species are not one and the same. As is expected of a tropical environment, the ants numerically predominated, and are the only pollinators when the plants occur in the fields of *Sorghum, Pennisetum* and maize. The importance of ants as pollinators becomes

much more obvious in view of the demonstration that when other insects are prevented from visiting flowers, there is virtually no difference either in fruit or seed set or in fecundity (Table 9). Although ants are invariably considered prototypes of nectar thieves, authentic cases of ant pollination are not uncommon (Hagerup 1932, Kinkaid 1963, Hickman 1974), and the present situation can be added to the list of such cases. As crawling insects spend relatively little energy on travelling (Heinrich & Raven 1972), the ant-pollinator interactions involve low expenditure of energy by both ant and plant, and establishes the following syndrome: dry-hot habitat; nectaries small, quantity of nectar too small to interest larger visitors; blossoms exposed near the ground, sessile, small with minimal visual attraction; few blossoms in anthesis at the same time, gregarious occurrence of several individuals further xenogamy; small quantities of sticky pollen prevents too eager cleaning, number of ovules per flower small (Hickman 1974, Faegri & Pijl 1979). The cyathial features of *E. geniculata* comply with most traits of the syndrome, but reveal that nectaries need not be small, and nectar volumes need not be limiting. But as already pointed out *E. geniculata* has not specialised to be serviced by ants alone; on the other hand, it is promiscuous.

TABLE 9

FRUIT AND SEED SET, AND FECUNDITY DUE TO ANT-POLLINATIONS *vs.* OTHERS IN *E. geniculata*

Insect type	No. of cyathia observed	No. of cyathia set fruit	Fruit set (%)	Seed set (%)	Fecundity (%)
Ants	535	513	95.88	95.38	91.46
Other insects	500	490	98.00	95.50	93.66

Interplant movements of ants are common. Even then, these crawling ants may be considered less effective in bringing about outcrossing. Ants are well known for their bellicosity, and this behaviour of ants is found indirectly helping the plant to achieve more outcrossing. The wasps which are only second in importance as pollinators, are scared at the ants and consequently move more often from inflorescence cluster to cluster and from plant to plant lapping up the open nectar. Thus the chances for the delivery of 'foreign' pollen by the wasps becomes maximised and the chances of geitonogamy are minimised.

Beetle pollination is characteristic of tropical zones and is not of much significance in temperate regions (Grant 1950, Proctor & Yeo 1975, Faegri & Pijl 1979). The beetles at the blossoms of *E. geniculata* were not encountered consistently throughout the pollinating season (Table 5). When they occurred, they carried out significant pollination. They were not found visiting the cyathia accidentally and so could be habitual visitors. They were found mostly licking up nectar perching on the cyathium proper, which being flat poses no problem. The size of the beetles is exactly suited to the cyathium and pollen is transferred sternotribically. Beetles tend to protect themselves by their horny exterior or their repellent secretions rather than by flight and so may linger in the same flower or inflorescence for hours (Proctor & Yeo 1975). The beetles concerned, behaved exactly the same way and could normally effect geitonogamy. Sometimes they did fly from one plant to the other and aided in some xenogamy. According to Faegri & Pijl (1979) nectar-feeding beetles are a late development and there is no special blossom type. The fact that *E. geniculata* is

promiscuous and is not specifically adapted to be pollinated by beetles alone, reinforces the above conclusion. Beetles are considered to feed destructively on flowers. So Grant (1950) has remarked that flowers adapted to beetle-pollination would be expected to have the ovules well protected from the chewing mandibles of the beetles. This, he suggests, might be provided by a form of perigyny in which the ovules are more or less sunken into the receptacle, epigyny (inferior ovaries) or the flowers may be closely aggregated so as to form a surface above the ovule. In a majority (80%) of beetle flowers, which he compiled, such characters were much more common. In *E. geniculata* there is no such adaptation. As the beetles concerned virtually feed on nectar, of course rarely on pollen, obviously selection might not have favoured the development of such protective measures.

Acknowledgements

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ADAPTIVE MODIFICATIONS OF THE REDUVIIDAE OF THE SCRUB JUNGLES AND SEMI-ARID ZONES OF THE PALGHAT GAP, INDIA — AN EVOLUTIONARY APPROACH[1]

D. Livingstone and D. P. Ambrose[2]

(*With sixty text-figures in five plates*)

Investigations on the tibiae of about 60 species of reduviids from the tropical rainforest, scrub jungle and semiarid ecosystems have shown different grades of development of tibial pads of the fore and mid legs. Tibial pads facilitate prey capture and they are totally absent in the characteristic species of the tropical rainforest ecosystem that provides an abundant supply of litter prey species. Tibial pads reach their maximum development in the characteristic species of the scrub jungle and semiarid ecosystems, where they have to depend on vagrant prey species that try to take shelter in the same concealment habitat. Diurnal activity; arboreal habit; alate condition without any type of sexual dimorphism with this regard; bright coloration; deposition of eggs in batches of 5-100 with strongly gluing material; eclosion — ecdysis — emergence periodicity in the fore and afternoons; almost straight and relatively slender rostrum etc. are complementary features of those species without tibial pads. Concealment habitats; alary polymorphism (females mostly apterous); warning coloration; deposition of eggs singly in several batches without any gluing substance; eclosion — ecdysis — emergence periodicity invariably during the scotoperiod; more curved stout rostrum etc. are complementary features of the species with tibial pads. Harpactorinae are represented by more number of species and are widely distributed in all three ecosystems whenever and wherever tropical rainforest conditions prevail and they are more original and are least specialized for life in the scrub jungles and semiarid ecosystems. Piratinae are extremely well specialized for life in semiarid zones and they are seldom found in tropical rainforests. Intermediate conditions of tibial pad development (pad-index) are found in Acanthaspidinæ.

Introduction

The evolution of the entire flora-fauna complex in a particular ecosystem is closely related to and profoundly influenced by the geomorphological evolution. Most of the peculiarities of the biogeography of India would remain meaningless if one ignores the decisive role of history on the changes in the land mass. Conditions operating at present have not given rise to the present day patterns of flora and fauna and their present day distribution represents a dynamic phase in the uninterrupted course of the biogeographical evolution in India that has by no means either stopped or even substantially slowed down. According to Mani (1974), the great bulk of true Indian

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flora and fauna had differentiated and evolved in the peninsula itself throughout the Palaeozoic, Mesozoic and Tertiary right nearly up to the Pleistocene and then spread over extra peninsular areas during late Tertiary. The original tropical humid forest fauna was very widely and continuously distributed throughout the peninsula. The presence of habitat fremd groups (ecologically anomalous) in the peninsula, according to Mani, is a strong evidence of the fact that formerly the whole peninsular fauna was a humid tropical one which was far more widely distributed throughout the peninsula than at present and that changes in the habitat have taken place within relatively recent times. Irreversible changes in the deterioration of ecosystems of the peninsula were induced by human agencies within historical times, since the close of last pleistocene glaciations on the Himalaya. Discovery of an increasing number of a wide range of pleistocene herbivorous mammalian fossils from the present day semiarid zones and scrub jungles of Southern India further convincingly support this view.

According to Champion & Seth (1968) and Meher-Homji (1974) the change from the original Miocene wet evergreen forest type to the present day dry evergreen type (Scrub jungle) may have taken place through an intermediate dry deciduous type, following the monsoon pattern of climate that originated subsequent to the uplift of the Himalaya and the maximum rise of the Western Ghats in the late Tertiary era. In most parts of the Palghat Gap, the annual rainfall rarely exceeds 600 mm, the dry season lasts for over eight months and the mean temperature of the coldest month seldom falls below 18°C. Geological changes are always indicated by phytosociology and the scrub jungles are associated with ferralitic sandy loams of mid Tertiary (Cuddalore sand stone formation). The characteristic composition of the fauna of a particular region is directly as well as indirectly influenced by the nature of the substratum (soil).

The geomorphology of Southern India is characterised by eastwardly directed offshoots of the Western Ghats that present a corona, having conditions similar to those of tropical rainforests; an apron of scrub jungles or dry evergreen forest (a product of human interference) and the plains consisting of the agroecosystem and the semi-arid barren land covered with thickets, sand dunes, chalk stones and granites. The substratum of the tropical rainforest ecosystem is humus laden, with an abundance of litter fauna such as Blattids,Termites, etc. providing a rich variety of food for an entomosuccivorous predator. On the contrary, in a chalk stone strewn hot semi-arid zone, where the impoverishment of prey species leaves no other alternative for a couching starved insect predator other than to wait in hiding for a stray, vagrant prey which, due to paucity of proper habitat conditions, tries to seek shelter underneath the same stone or a bark of a tree that invariably becomes its graveyard. Accumulation of heaps of cases of prey in a particular microhabitat is a sure indication of the presence of a predator. Studies on the natural history of a large number of species of Reduviidae of diverse habitats of the Palghat Gap, carried out in the Division of Entomology, Post-graduate Centre, Coimbatore for the past four years have prompted the authors to probe into several possibilities pertaining to the origin and evolution of structural adaptations of these bugs in this region.

Results and Discussion

1. *Distribution of Reduviidae of Southern India* (*Tamil Nadu*):

From the collection data of 77 species of reduviids (owing to extensive damage caused to stored specimens, details of 55 more species could not be presented here with certainty) maintained in the Division of Entomology, it is evident (Table 1) that species abundance, morphological diversifications and ecotypic specializations are more significant in those species collected from the semi-arid zones of the Palghat Gap. Out of the 77 species investigated, 64 species have been recorded in the semi-arid zones, 25 from the tropical rain forests and 17 from scrub jungles. Out of these, eight species, viz. *Coranus atricapillus, C. spiniscutis, Coranus* spp. (2), *Acanthaspis zebraica, Triatoma rubrofasciatus, Ectomocoris ochropterus,* and *Rhinocoris marginellus* are found exclusively (characteristic species) in the semi-arid zones; two species, viz. *Rhinocoris* sp. and *Petalochirus brachialis* are found exclusively in the scrub jungles and eleven species, viz. *Holoptilus fasciatus, H. melanospilus, Irantha armipes, Lophocephala guerini, Endochus cingalensis, E. iroratus, Euagoras plagiatus, Cydnocoris gilvus, Polididus armatissimus, Sycanus ater* and *Nabis capsiformis* (Nabidinae) are exclusively found in the tropical rainforests as well as in the corona of hillocks where tropical rainforest conditions prevail. Five species, viz. *Raphidosoma atkinsoni, Rhinocoris fuscipes, Acanthaspis pedestris, Ectomocoris erebus,* and *Piratus affinis* have been found in semi-arid zones, in scrub jungles as well as in the aprons of the tropical rainforests during summer when conditions of scrub jungles prevail. *Sphedanolestes aterrimus,* an inhabitant species of tropical rainforest is found in areas of the scrub jungles during heavy monsoon when tropical rainforest conditions prevail. However, the presence of *A. pedestris* in a very restricted rocky area of a dense tropical rainforest in the Palghat Gap, creates considerable interest. This species is a characteristic species of scrub jungles and semi-arid zones and manifests extremely variable ecotypic characters (Livingstone & Ambrose 1978b). Whereas all ecotypes of this species collected from these two ecosystems do not exceed 14 mm in length and 4 mm in breadth, the ecotype of the tropical rainforest is not less than 16 mm long and 4.5 mm broad, with relatively longer appendages and is more darkly pigmented. While all available ecotypes of the two ecosystems could be readily reared successfully in the laboratory on camponotine ants, the tropical rainforest ecotype refuses to feed in captivity and fails to continue all its activities under laboratory conditions. It may tempt one to suggest that the tropical rainforest ecotype of *A. pedestris* may have been transported from the plains by human agency in the process of transport of timber, granites and other building materials and due to ecological isolation acquired certain specialized

Table 1

Ecomorphological distribution of reduviids of Tamilnadu (cf. Figs. 58, 59 & 60)

Morphological variations	Habitat: Semiarid zones	Habitat: Scrub jungles	Habitat: Tropical rain forests
1. Alate forms	48	10	16
2. Brachypterous forms	3	2	3
3. Micropterous forms	1	1	1
4. Apterous forms	12	4	5
5. Species with tibial pads both in the fore- and mid-legs	33	13	9
6. Species with tibial pad only in foreleg		1	0
7. Species without tibial pad	32	4	16

adaptations for life in tropical rainforest.

It is clear from Fig. 58 that Coimbatore District which is located in the Palghat Gap has the maximum number of genera and species of reduviids recorded.

Fig. 59 indicates that Harpactorinae predominates with 32 species, closely followed by Acanthaspidinae (22 species) and Piratinae (19 species). The least represented families are Tribelocephalinae and Nabidinae. The latter subfamily is now removed from Reduviidae. But, for the purpose of tracing its relationship in respect of the development of tibial pad, it is treated here along with Reduviidae. Interestingly, the subfamily Apiomerinae is not represented. Fig. 60 shows that the tropical rainforests and semi-arid zones have larger number of alate species whereas in scrub jungles, the apterous species predominate.

Table 1 indicates that though the number of species recorded in the semi-arid zone is more, the number of characteristic species recorded (endemic) in the tropical rainforests is significantly high. Whereas the characteristic species of the semi-arid zones and scrub jungles are either alate, micropterous, brachypterous or apterous and most of them are provided with tibial pads of varying degrees of development, all the characteristic species of the tropical rainforests are significantly (without any exception) alate and all are without tibial pads (Table 2). Interestingly, a large number of alate species without tibial pads (Harpactorinae) are found in all the three ecosystems.

2. *Adaptive modifications and their evolutionary significance* :

Analysis of certain distinctive features such as the nature of development of the tibial pads; wings and coloration; relative curvature of the rostrum; predatory efficiency; egg deposition pattern; fecundity rate; longevity; sex ratio; eclosion-ecdysis emergence periodicities; relative development of cannibalistic tendency; camouflaging behaviour; hardiness etc. of more than 60 species of Reduviidae from the Palghat Gap and certain other areas of Southern India (Tamil Nadu) have led to the following conclusions.

a. Except *Lophocephala guerini,* a coprophagous harpactorine species of the tropical rainforest (Ambrose and Livingstone 1979) and a couple of species of Haematorrhophus (Echtrichodiinae) that feed on millipedes, all other recorded species are entomosuccivorous. Most of the tropical rainforest species, because of the abundance and diversity of prey (litter forms), are polyphagous whereas most of the species of the semi-arid zones and scrub jungles are predominantly monophagous, feeding on Camponotine ants and are rarely found to be oligophagous.

b. All the characteristic species of tropical rainforests are alate and are not sexually dimorphic in this regard. Most of them are brightly coloured, with reddish tinge predominating, without any kind of warning coloration. They are arboreal and conspicuously diurnal. They have no tibial pads and their rostrum is almost always straight or broadly crescentic. They are invariably found running by lifting the prey at ease (Fig. 56). Their eggs are glued to the substratum as well as to each other with cementing material, in batches (Fig. 57) of five to over hundred eggs in each batch. Eclosion, ecdysis and emergence periodicities have been found to be mostly in the forenoon and afternoon. There is no nymphal camouflaging and the insects are less hardy.

c. In the scrub jungles and in the semi-arid zones there are more number of apterous or micropterous or brachypterous species and the females of alate species are seldom alate. Most of them have well formed tibial pad

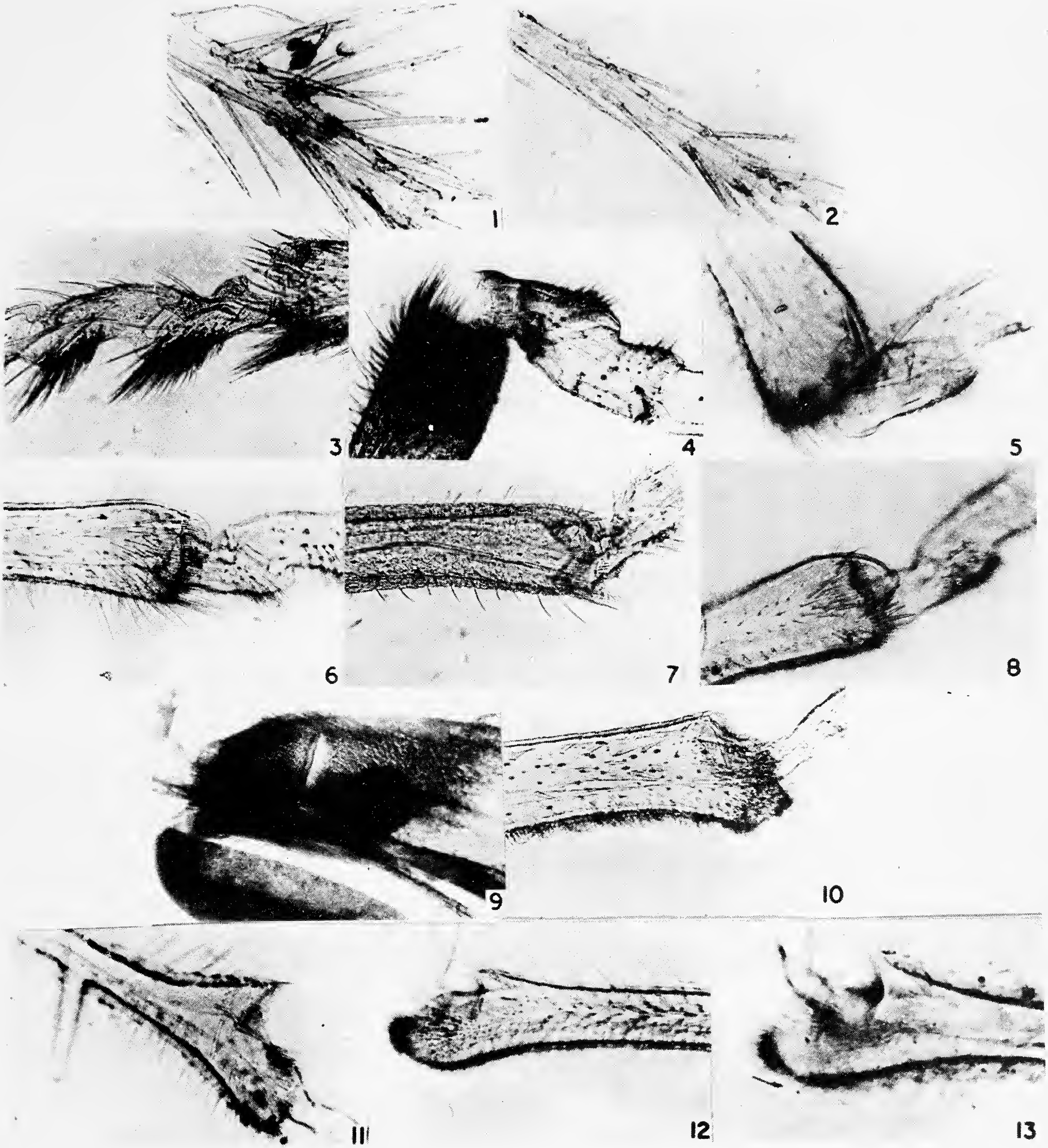

Fig. 1. *Holoptilus fasciatus* Reut.; Fig. 2. *Holoptilus melanospilus* Walk.; Fig. 3. *Oncocephalus annulipes* Stal; Fig. 4. *O. klugi* Dist. (reversed); Fig. 5. *O. notatus* Krug.; Fig. 6. *O. modestus* Reut.; Fig. 7. *O. fuscinotum* Reut.; Fig. 8. *Staccia diluta* Stal; Fig. 9. *Haematorrhophus* sp.; Fig. 10. *Neohaematorrhophus* sp.; Fig. 11. *Polididus armatissimus* Stal; Fig. 12. *Lophocephala guirini* Laporte; Fig. 13. *Sphedanolestes aterrimus* Dist.

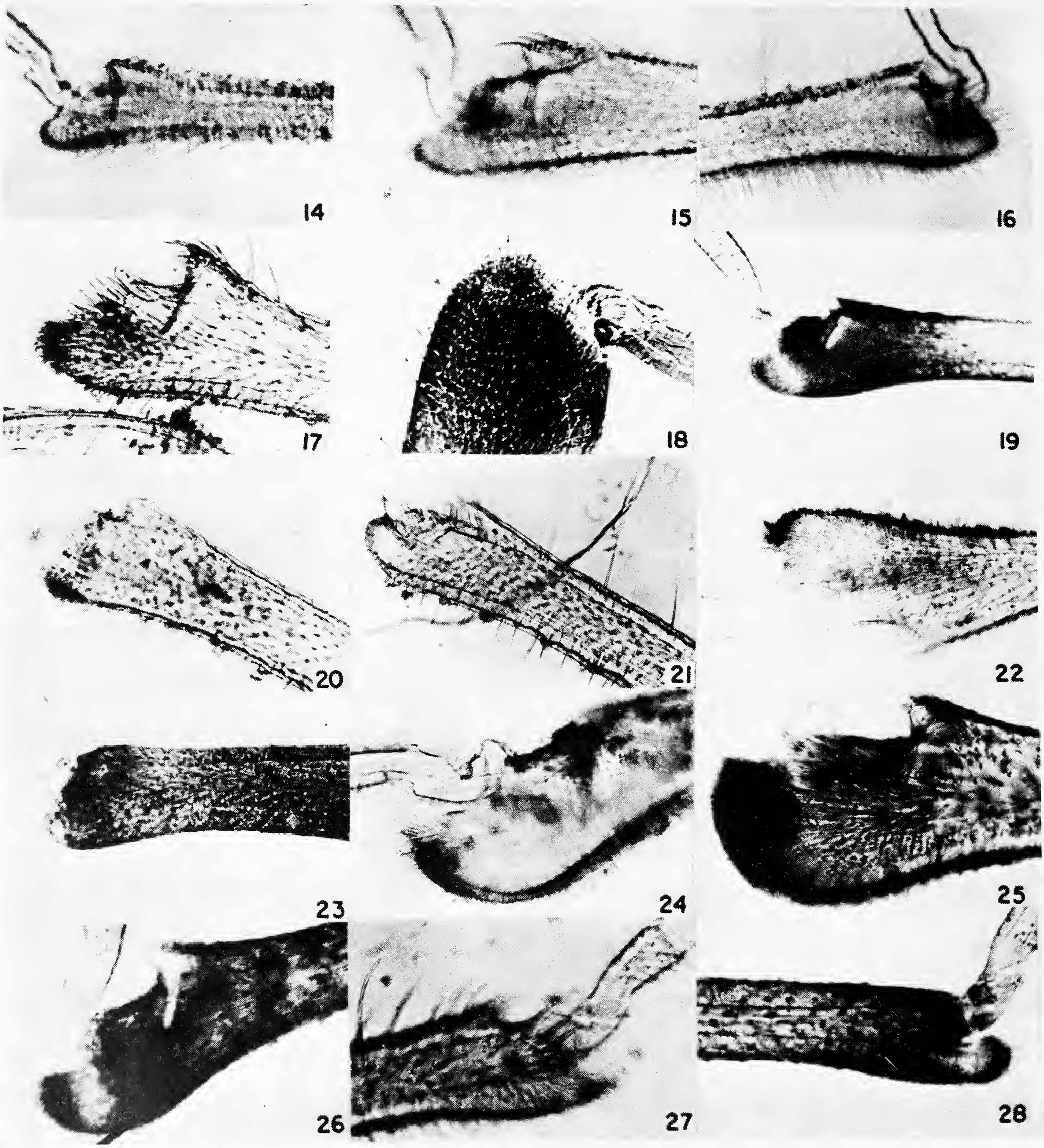

Fig. 14. *Rhaphidosoma atkinsoni* Bergr.; Fig. 15. *Coranus vitellinus* Dist.; Fig. 16. *Coranus* sp.; Fig. 17. *Coranus* sp.; Fig. 18. *Coranus atricapillus* Dist.; Fig. 19. *C. spiniscutis* Reut.; Fig. 20. *Irantha armipes* Stal; Fig. 21. *I. consobrina* Dist.; Fig. 22. *Endochus cingalensis* Stal (reversed); Fig. 23. *E. inoratus* Stal; Fig. 24. *Euogoras plagiatus* Burm.; Fig. 25. *Rhinocoris kumarii* sp. nov.; Fig. 26. *R. fuscipes* Fabr.; Fig. 27. *R. maginellus* Fabr.; Fig. 28. *R. longifrons* Stal.

TABLE 2

REDUVIIDAE OF SOUTHERN INDIA (TAMILNADU) — DIAGNOSTIC FEATURES PURPORTING TO EVOLUTIONARY TREND

INSECT	HABITAT	INSECT SIZE IN MM.		FORE TIBIA SIZE		FORE TIBIAL PAD SIZE IN MM.		TIBIAL INDEX (TL × TW/IL × IW)	TIBIAL PAD INDEX (TPL × TPW/TL × TW)	NATURE OF WING	NATURE OF ROSTRUM	NATURE OF EGG DEPOSITION
		L	W	L	W	L	W					
1	2	3	4	5	6	7	8	9	10	11	12	13
I. HOLOPTILINAE												
1. *Holoptilus fasciatus* Reut.	TRF	7.5	1.75	2.2	2.28	—	—	0.047	—	Alate	AS	—
2. *H. melanospilus* Walk.	TRF	6.5	1.5	2.1	0.2	—	—	0.045	—	,,	AS	Glued
II. STENOPODINAE												
3. *Oncocephalus annulipes* Stal	SA,SJ	20.5	4.5	5.9	0.36	—	—	0.02	—	,,	SC	Loose
4. *O. fuscinotum* Reut.	SA,SJ	9	2	2.2	0.28	—	—	0.034	—	,,	SC	,,
5. *O. klugi* Dist.	SA,SJ	17	4	3.5	0.46	—	—	0.02	—	,,	SC	,,
6. *O. modestus* Reut.	SA,SJ	18	3	3.2	0.4	—	—	0.02	—	,,	SC	,,
7. *O. notatus* Klug.	SA,SJ	14	3	3.86	0.36	—	—	0.03	—	,,	SC	,,
8. *Sastrapada baerensprungi*	SA,SJ	18	2	2.66	0.3	—	—	0.02	—	,,	AS	—
9. *Staccia diluta* Stal	SA,SJ	8.5	1.5	1.64	0.24	—	—	0.03	—	,,	SC	—
III. ECHTRICHODIINAE												
10. *Neohaematorrhophus* sp.	SA,SJ	7.5	2.75	2.0	0.4	—	—	0.04	—	M-al-F-apt.	C	Glued
11. *Haematorrhophus* (?)	SA,SJ,TRF	25	8	7.6	1.44	3.12	0.86	0.055	0.245	apt.	C	Loose

IL = Insect length; IW = Insect Width; TL = Tibial length;
TW = Tibial Width; TPL = Tibial pad length; TPW = Tibial pad width.

TABLE 2 (contd)

1	2	3	4	5	6	7	8	9	10	11	12	13
IV. HARPACTORINAE												
12. *Coranus atricapillus* Dist.	SA	6	2	1.96	0.30	0.08	0.24	0.05	0.03	Alate	SC	Glued
13. *C. spiniscutis* Reut.	SA	9.5	3	2.76	0.30	—	—	0.03	—	,,	SC	,,
14. *C. vitellinus* Dist.	SA,SJ	9.75	3.5	3.04	0.30	—	—	0.03	—	,,	SC	,,
15. *Coranus* sp.	SA	9.5	2.75	3.3	0.34	—	—	0.04	—	,,	SC	,,
16. *Coranus* sp.	SA	9	3.5	3.44	0.24	—	—	0.026	—	,,	SC	,,
17. *C. gilvus*	TRF	17	4.5	5.3	0.54	0.4	0.48	0.037	0.06	,,	SC	,,
18. *Endochus cingalensis* Stal.	TRF	18	3.75	7.8	0.48	—	—	0.055	—	,,	SC	,,
19. *E. inornatus* Stal	TRF	22	3.5	8.9	0.4	—	—	0.046	—	,,	SC	—
20. *E. plagiatus* Bwym.	TRF	18	2.5	6	0.28	—	—	0.037	—	,,	C	—
21. *Irantha armipes* Stal.	TRF	11.5	2	3.46	0.36	—	—	0.043	—	,,	S	Glued
22. *I. consobrina* Dist.	TRF,SJ	9	1.5	3.4	0.26	—	—	0.065	—	,,	S	,,
23. *Lophocephala guerini* Laporte	TRF	16.5	4.00	5.5	0.4	—	—	0.033	—	Alate	S	Glued
24. *Polididus armatissimus* Stal	TRF	10.5	1.5	3.4	0.66	—	—	0.14	—	,,	C	Loose
25. *Rhaphidosoma atkinsoni* Bergr.	SJ,SA TRF	22	1.2	10.6	0.34	—	—	0.116	—	Apt.	S	Glued
26. *Rhinocoris marginatus* Fabr.	SA,SJ	18	5.5	6.9	0.56	—	—	0.038	—	Alate	SC	Glued
27. *R. marginellus* Fabr.	SA	11.5	4.00	3.9	0.44	—	—	0.037	—	Alate	SC	,,
28. *Rhinocoris* sp.	SJ	18.5	5.00	7.2	0.5	—	—	0.038	—	,,	SC	,,
29. *R. fuscipes* Fabr.	SA,SJ TRF	12.85	3.8	4.95	0.28	0.2	0.36	0.028	—	,,	SC	,,
30. *R. longifrons* Stal	SA,SJ	14	4.00	3.84	0.32	0.24	0.02	0.028	0.039	,,	SC	,,
31. *Sphedanolestes aterrimus* Dist.	SJ,TRF	8.5	1.5	3.2	0.3	—	—	0.075	—	,,	AS	
32. *S. ater*	TRF	18	3.5	10.9	0.24	0.24	0.08	0.04	0.001	,,	C	—

TABLE 2 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
V. SALYAVATINAE												
33. *Lisarda annulosa* Stal	SA,SJ	10.5	1.5	2.76	0.4	0.66	0.24	0.07	0.143	,,	SC	Loose
34. *Paralisarda* sp.	SJ,SA	10	2.00	1.94	0.52	0.64	0.16	0.05	0.101	Apt.	C	Loose
35. *Petelochirus brachialis* Stal	SJ	14	2.5	3.64	1.74	0.24	0.84	0.18	0.032	Alate	C	—
VI. ACANTHASPIDINAE												
36. *Acanthaspis pedestris* Stal	SA,SJ TRF	13.5	3.75	3.7	0.56	1.24	0.26	0.15	0.156	Mcp	AC	Loose
37. *A. siva* Dist.	SA,SJ	16.5	5.5	5.24	0.68	3.2	0.6	0.039	0.539	Alate	AC	Loose
38. *A. quinquespinosa* (L.) Fabr.	SA,SJ	16.5	5.5	5.04	0.6	1.8	0.28	0.033	0.167	,,	AC	Loose
39. *A. zebraica* Dist.	SA	11	3.5	2.44	0.46	0.84	0.16	0.029	0.119	,,	AC	Loose
40. *Edocla slateri* Stal	SA,SJ	9.5	3.25	2.54	0.26	0.8	0.2	0.021	0.242	,,	AC	Glued
41. *Triatoma rubrofasciatus* DeGeer	SA	23	5.75	5.8	0.6	0.2	0.36	0.026	0.02	,,	AS	Loose
VII. PIRATINAE												
42. *Catamiarus brevipennis* Serv.	SA,SJ	25	8.0	6.0	1.28	3.5	0.76	0.038	0.338	Br.	Sh. C.	Loose
43. *Ectomocoris atrox* Stal	SA,SJ	14	4	4.44	0.66	3.44	0.60	0.05	0.703	Alate	Sh. C	Loose
44. *E. cordatus* Wolff.	SA,SJ	12.5	2.5	3.16	0.48	2.16	0.40	0.049	0.57	,,	Sh. C	Loose
45. *E. cordiger* Stal	SA,SJ	14	4.25	4.1	0.64	3.2	0.56	0.044	0.683	Alate	Sh. C	Loose
46. *E. elegans* Fabr.	SA,SJ	15	4	4.4	0.44	3.06	0.56	0.032	0.885	,,	Sh. C	,,
47. *E. erebus* Dist.	SA,SJ TRF	15	4.0	4.1	0.46	3.10	0.56	0.031	0.92	Br.	Sh. C	,,
48. *E. gangeticus* Bergr.	SA,SJ	15	3.5	4.75	0.54	3.8	0.66	0.048	0.98	Br.	Sh. C	--
49. *E. ochropterus* Stal	SA	16	3.5	5.9	0.68	3.44	0.66	0.072	0.566	Br.	Sh. C	—
50. *E. tibialis* Dist.	SA,SJ	15	3.5	4.76	0.50	3.08	0.52	0.046	0.672	Br.	Sh. C	Loose
51. *E. quadriguttatus* Fabr.	SA,SJ	9	2.75	5.1	0.54	4.4	0.64	0.111	1.02	Alate	Sh. C	,,
52. *Ectomocoris* sp.	SA,SJ	15	4	3.3	0.30	2.60	0.36	0.017	0.945	Alate	Sh. C	,,
53. *Ectomocoris* sp.	SA,SJ	15	4	4.54	0.64	2.8	0.7	0.048	0.675	,,	Sh. C	,,
54. *Piratus affinis* Serv.	SA,SJ TRF	23	5.5	5.2	1.06	0.56	2.00	0.043	0.203	M-al. F-apt.	Sh. C	Loose
55. *P. quadrinotatus* Fabr.	SA,SJ	18	4.5	2.4	0.36	1.2	0.36	0.01	0.5	Alate	Sh. C	Loose

TABLE 2 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13
56. *Pirates* sp.	SA,SJ	13.5	3.75	3.24	0.36	1.36	0.2	0.023	0.233	,,	Sh. C	,,
57. *Pirates* sp.	SA,SJ	21	4	4.36	1.0	1.80	0.48	0.051	0.198	,,	Sh. C	—
58. *Sirthenea flavipes* Stal	SA,SJ	12.5	3	2.7	0.4	1.4	0.4	0.029	0.519	,,	Sh. C	—
VIII. NABIDINAE												
59. *Nabis capsiformis* Germ.	TRF	9	1.5	2.38	0.24	0.24	0.08	0.042	0.034	,,	SC	—

AC = Acutely curved; Al = Alate; Apt. = apterous; AS — Almost straight; Br = Brachypterous; C = Crescentic; F = Female; L = Length; M = Male; Mcp = Micropterous; S — Straight; SA = Semiarid zone; SJ = Scrub jungle; SC = Slightly crescentic; Sh.C = Sharply crescentic; TRF = Tropical rainforest; and W = Width.

on both the fore and mid tibiae and very rarely on the foretibiae alone. Eggs of most species are deposited singly, haphazardly without any cementing material and have more number of batches with less number of eggs in each batch. Eclosion, ecdysis and emergence periodicities are found mostly at dusk or at night. The rostrum is acutely curved (Fig. 55) and the prey is seldom lifted. Most characteristic species are with warning coloration (Black and yellow) and are extremely hardy. Cannibalistic tendency is significantly developed and nymphal camouflaging is found only in Acanthaspidinae where this tendency is better defined and characterised.

The relative development of the tibial pads has been considered here as a visible indication of predatory efficiency in Reduviidae (Livingstone and Ambrose 1978a) and this character has been taken as a significant index of adaptive evolution of the Reduviidae of the scrub jungles and semi-arid zones of this region. All other characters such as progressive curvature of the rostrum; nature of the eggs and the pattern of oviposition; eclosion, — ecdysis — emergence periodicity patterns, alary polymorphism; cannibalistic tendency and nymphal camouflaging and warning coloration are considered supplementary attributes to predatory efficiency in an adverse ecosystem.

According to the steps in the origin and evolution of tibial pads as proposed here (Table 3), the Holoptilinae [*Holoptilus fasciatus* (Fig. 1) and *H. melanospilus* (Fig. 2)] have very slender, more elongated tibiae, provided with very long, slender, (plumose type) movable spines. This type is structurally the least specialized in prey capture, presumably originated from Cimicid stock. The next step in the development of tibial pad is marked by better defined concentration of sharp spines on the ventral extremity of each tibia as well as the tarso-

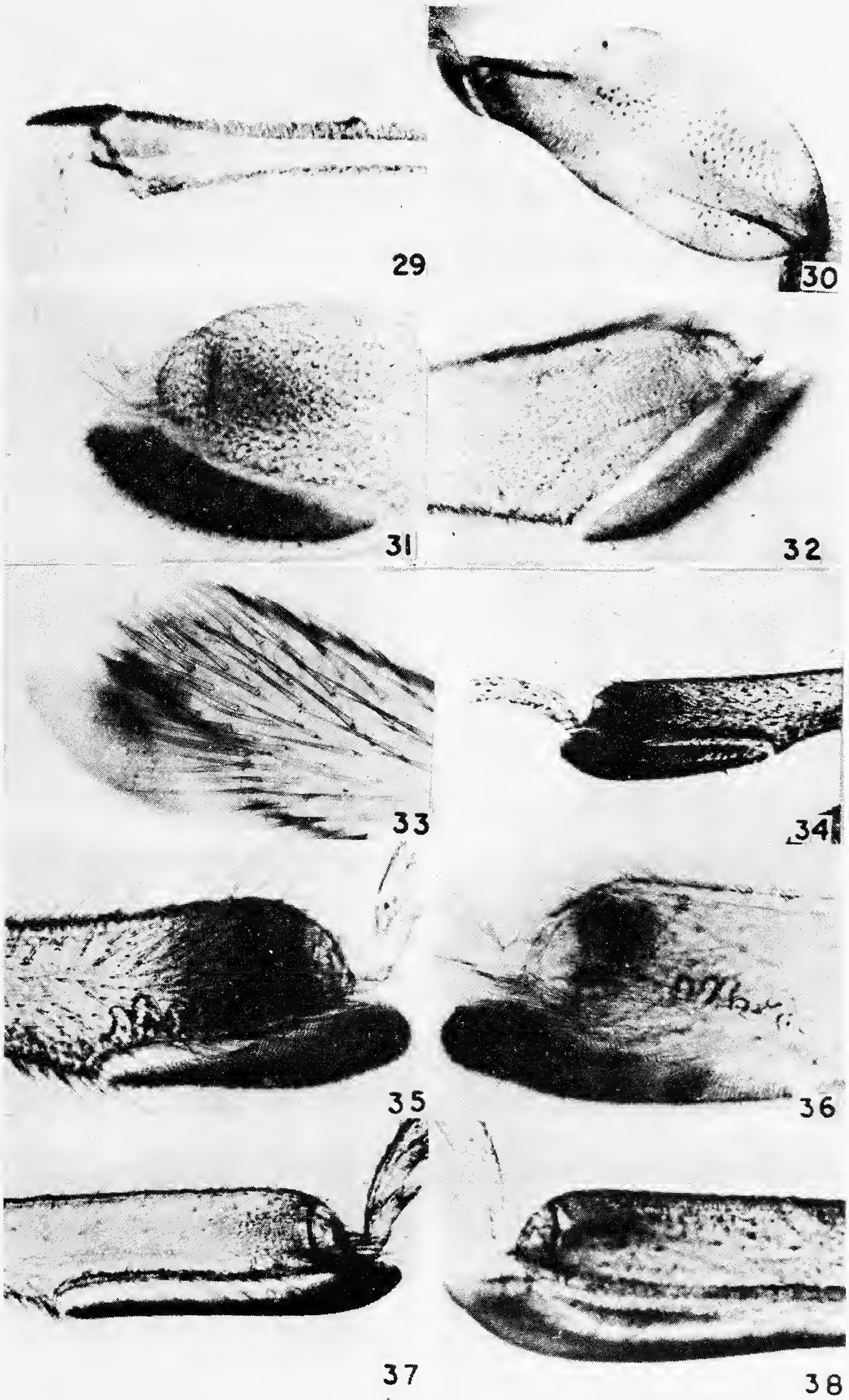

Fig. 29. *Nabis capsiformis* Germ (reversed); Fig. 30. *Petalochirus brachialis* Stal; Fig. 31. *Paralisarda* sp.; Fig. 32. *Lisarda annulosa* Stal; Fig. 33. *Triatoma rubrofasciatus* Degeer; Fig. 34. *Acanthaspis pedestris* Stal; Fig. 35. *A. zebraica* Dist.; Fig. 36. *Edocla slateri* Stal; Fig. 37. *Acanthaspis quinquespinosa* (L.) Fabr.; Fig. 38. *A. siva* Dist.

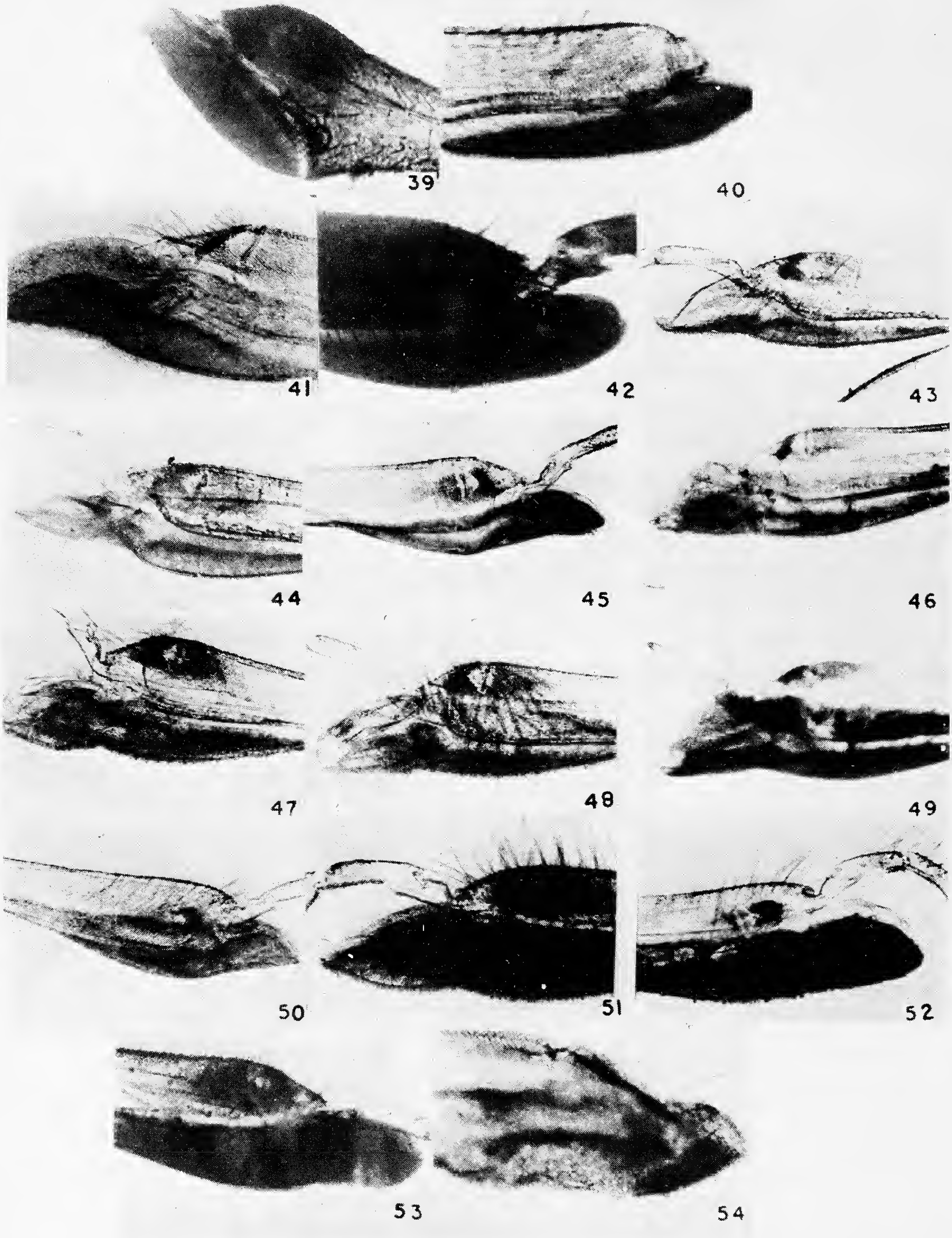

Fig. 39. *Piratus affinis* Serv.; Fig. 40. *Piratus* sp.; Fig. 41. *P. quadrinotatus* Fabr.; Fig. 42. *Catamiarus brevipennis* Serv.; Fig. 43. *Ectomocoris elegans* Fabr.; Fig. 44. *E. erebus* Dist.; Fig. 45. *Ectomocoris* sp.; Fig. 46. *E. atrox* Stal.; Fig. 47. *E. cordatus* Wolff.; Fig. 48. *Ectomocoris* sp.; Fig. 49. *E. ochropterous* Stal; Fig. 50. *E. cordiger* Stal; Fig. 51. *E. quadriguttatus* Fabr.; Fig. 52. *E. gangeticus* Bergr.; Fig. 53. *E. tibialis* Dist.; Fig. 54. *Serthenea flavipes* Stal.

TABLE 3

PROPOSED STEPS IN THE ORIGIN AND EVOLUTION OF TIBIAL PADS IN REDUVIIDAE

	ECTOMOCORIS	
	CATAMIARUS	SIRTHENEA
	PIRATES	
	PIRATINAE	
	ACANTHASPIS	
	EDOCLA	
	ACANTHASPIDINAE	
	PARALISARDA	
TRIATOMINAE	LISARDA	NABIDINAE
	PETALOCHIRUS	
	SALYAVATINAE	
	RHINOCORIS	
	EUAGORAS	
	ENDOCHUS	
	IRANTHA	
	CORANUS	
	SPHEDANOLESTES	HAEMATORRHOPHUS
	RHAPHIDOSOMA	
	LOPHOCEPHALA	NEOHAEMATORRHOPHUS(?)
	POLIDIDUS	
	HARPACTORINAE	ECHTRICHODIINAE
	STACCIA	
	ONCOCEPHALUS	
	STENOPODINAE	
	TRIBELOCEPHALINAE	
	APIOMERINAE (?)	
	EMESINAE	
	HOLOPTILUS	
	HOLOPTILINAE	
	CIMICID STOCK (?)	

meres, as exhibited by members of the subfamily Stenopodinae (Figs. 3 to 8). In *Oncocephalus annulipes* (Fig. 3) the extremities of tibiae and tarsomeres on their ventral surface bear more prominent tuft of bristles. Gradual reduction in the bushy nature of these bristles and subsequent replacement by more stiff spines on the ventral surface of the tibial extremity in all the legs, as found in *Staccia diluta* (Fig. 8) appear to be a clear indication of the initial stage in the process of tibial pad formation as seen in *O. notatus* (Fig. 5). From such a condition, members of the subfamily Echtrichodinae appear to have been branched off as an off shoot through *Neohaematorrhophus* (?) (Fig. 10) which is an entomosuccivorous species having least differentiation of tibial pads, found in semiarid zones as well as scrub jungles, to several other species of *Haematorrhophus* (*Physorrhynchus*) having well developed tibial pads in the fore and midlegs and prominent tibial comb. They feed exclusively on millipedes.

Further differentiation of the tibial extremity of an *Oncocephalus notatus* type is marked by more expanded tibial comb on its dorsal surface in the harpactorine species as indicated in *Polididus armatissimus* (Fig. 11) with prominent sensory bristles. Subsequent stages of development of tibial extremity are marked by gradual reduction of the dorsal tibial comb with a corresponding enlargement of the ventral surface of its distal extremity as found in *Lophocephala guerini* (Fig. 12) a coprophagous species having very restricted distribution in certain patches of the tropical rainforests and in *Sphedanolestis aterrimus* (Fig. 23), also a characteristic entomosuccivorous species of the tropical rainforest. In all the harpactorine species examined, there is a step by step reduction of the dorsal tibial comb, almost synchronising with the development of the precursor of tibial pad as expansion of the ventral surface of its distal extremity (Figs. 14-28), but for a few exceptions among the *Rhinocoris* species. Development of precursors of tibial pad in all 3 pairs of legs in *Rhinocoris* sp. (Fig. 25), a scrub species having very restricted distribution in a hillock near Cape Comorin, is significant whereas in all other harpactorine species, the fore and mid legs alone develop precursors of tibial pad. *Rhinocoris longifrons* appears (Fig. 18) to have developed a better defined tibial pad among the harpactorine species and therefore it is considered here as better adapted among the Harpachorinae in a scrub jungle and a semi-arid ecosystem.

The next stage of tibial pad development closely following the harpactorine *Rhinocoris* pattern, is found in the sub-family Salyavatinae. The highly expanded condition of the fore leg tibia and the distinct differentiation of the tibial pad as a small lobe ventral to the distal extremity of the tibia is found in *Petalochirus brachialis* (Fig. 30), an exclusive scrub species, manifesting extreme condition of specialization of tibia. Information available at present cannot adequately explain this phenomenon. In another two species of Salyavatinae viz. *Lisarda annulosa* and *Paralisarda* sp. (Figs. 31 & 32) the trend in the development of tibial pad is clearly marked towards the acanthaspidine pattern.

It is worthwhile to record here that *Nabis capsiformis* has developed a distinct tibial pad closely resembling that of the Salyavatinae. Distant (1904) considered this species as a representative of Nabidinae, a sub-family of Reduviidae. At present it is removed from Reduviidae and elevated to the status of a family (Nabididae) relating it closely to Cimicoid families (Carayon 1950). The development of a distinct tibial pad in *N. capsiformis*

may tempt one to suggest its closer relationship with the Salyavitinae.

Among Acanthaspidinae, the haematophagous species *Triatoma rubrofasciatus* (Fig. 33) differs from all other entomosuccivorous species in having greatly developed spinocity of tibial extremity with more soft tibial pad, having the least tibial pad index (0.02), suggesting a specialization associated with haematophagy. Among Acanthaspidinae, *Acanthaspis siva* (Fig. 38) has attained the maximum development of tibial pad, having reached the index 0.539. In almost all species of Acanthaspidinae, development of subapical lateral tibial comb, which is structurally different from the dorsal tibial comb of lesser harpactorinae, is considered here as an additional evidence of tibial differentiation towards tibial pad formation.

The sub-family Piratinae has attained the maximum development of tibial pads which are relatively more soft, extending beyond the tibial extremity, almost reaching the entire length of the tarsomeres. The genus *Piratus* has the tibial combs (Fig. 41) similar to those of Acanthaspidinae and the maximum development of tibial pad index is 0.5 indicating a closer resemblance in both. The genus *Ectomocrois* has the tibial combs almost invariably lost and the pads have reached the maximum degree of development (Figs. 43-53). *E. guadriguttatus* has the unique distinction of having gained the highest tibial pad index (1.02). They take relatively less time in capturing the prey (Livingstone and Ambrose 1978a).

Sirthenea flavipes, a Piratine species of the scrub jungles, alone has the tibial pads developed only on the fore legs and the pad index is intermediate between *Pirates* and *Ectomocrois.* It is considered here as a deviation (specialization) from the direct line of tibial pad evolution.

In *Rhodnius prolixus*, the tibial pad was considered as an adaptation for climbing on smooth surface (Wigglesworth 1938). Miller (1938, 1952 & 1956), after having examined the multiple arrangement of hairs on the "fissula spongiosa" (tibial pad) of a number of species, concluded that provision of such structures either in the fore or mid tibiae or both has mechanical advantage in prey capture, facilitating proper grasping of the prey, Edwards (1962 and 1965) after having studied the arrangement of hairs in three different series on the tibial pads and the secretory material that is found in them corroborated Miller's view. Investigations on the chronological aspects of the feeding behaviour and predatory efficiency of a large number of species of reduviids of the Palghat Gap led Livingstone and Ambrose (1978a) to conclude that the reduviids with tibial pads are better adapted for capturing and pinning the prey.

The foregoing comparative account of the development of the tibial pads in Reduviidae, as summarised in table 2, provides additional evidences to suggest that the tibial pads in these insects have direct impact on their life in their ecosystem and that their relative development is directly related to the gradual transformation of tropical rainforests into scrub jungles and semiarid conditions. It is also clear that the maximum extent of development of tibial pad as seen in *Ectomocoris* (Piratinae), a characteristic species of both scrub jungles and semiarid zones, has a number of intermediate stages represented by Acanthaspidinae. Whereas the characteristic species of the tropical rainforests do not have even a well organized precursor of the tibial pad and all of them are alate, diurnal, arboreal and deposit their eggs vertically in batches with gluing material, the characteristic species of the scrub

jungles and semiarid zones are all with tibial pads. Paucity of prey species in these two ecosystems necessitates these species to augment every effort to prevent any vagrant prey from escaping a firm grip, provided by the tibial pads. Ecotypic specializations, alary polymorphism, crepuscalar activity in a concealment habitat, warning coloration, deposition of eggs singly and haphazardly without any gluing material, cannibalistic tendency and nymphal camouflaging, as commonly observed among species of these two ecosystems are considered here as mere complementary attributes for life in adverse conditions.

The fact that the Southern Block of Indian peninsula was covered with wet tropical rainforest till late Tertiary era and since then radical transformations of ecological conditions have occurred in historical times (Mani 1974) may guide one to suggest that the original reduviid fauna of the Palghat Gap was spread all over and was alate, arboreal and without tibial pad. At present the Harpactorinae (Table 2) has the maximum number of species and their representation in the scrub jungles and semiarid zones is more during heavy monsoon when tropical rainforest conditions prevail. Louis (1974) has reported that "the harpactorines are in some respects (vide infra) the most advanced reduviids. Considering their distribution all over the globe and the fact that Harpactorinae contains the largest number of species found in any sub-family of Reduviidae, they are the most successful reduviids". Since Harpactorinae are better represented when tropical rainforest conditions prevail in an ecosystem in this region it is reasonable to suggest that Harpactorine species are more original and least specialized and could survive only when tropical rainforest conditions prevail and prey species are available in plenty in the litter. All other species with tibial pads are specialised for life in drought prone ecosystems where prey species are scarce and competition is more acute.

The harpactorine species in this region deposit their eggs in batches and glue them together, an indication of parental care, as reported by Louis (1974). Available information on the natural history of the reduviids of this region does not provide any evidence of parental care though material and parental care in Reduviidae have been reported only in harpactorines such as *Rhinocoris albospilosus* (Odhiambo 1959) and in *Poisilus tipuliformis* (Parker 1965). According to Cobben (1968) "it is a recently evolved character in view of the advanced type of the harpactorine embryogenesis" and laying eggs in batches and gluing them according to him is "an approach to formation of ootheca is that standing eggs are covered with sticky substance". If this criterion is given consideration it is certainly a primitive feature. Louis (1974) however attaches the importance of survival value under such conditions of egg deposition. Therefore, it is argued that the Harpactorinae of the Palghat Gap represent the original, least specialized reduviid stock of the Southern Block of peninsular India.

ACKNOWLEDGEMENTS

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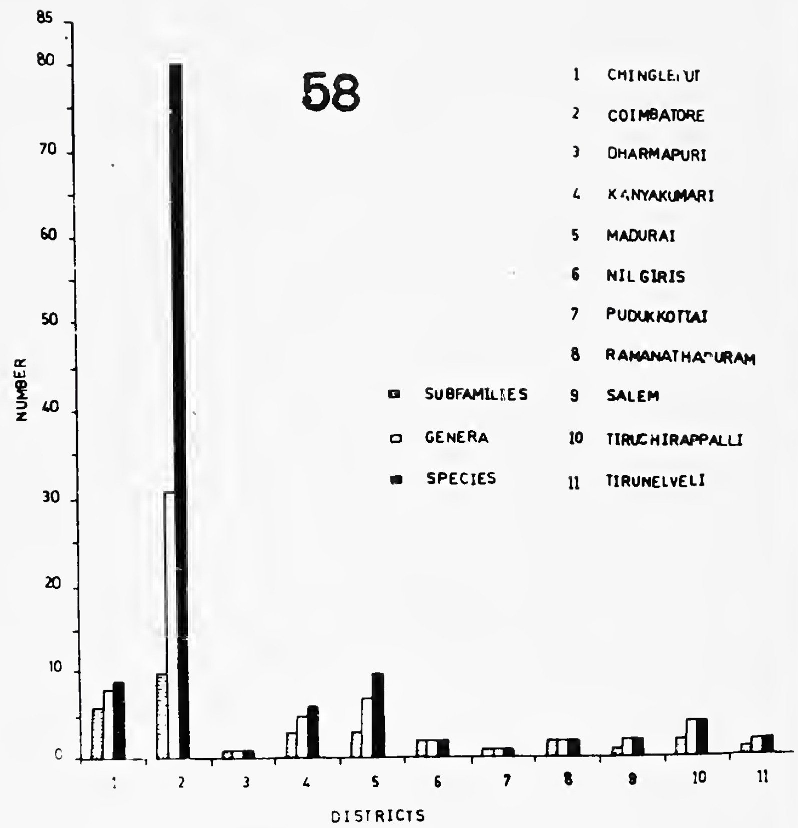

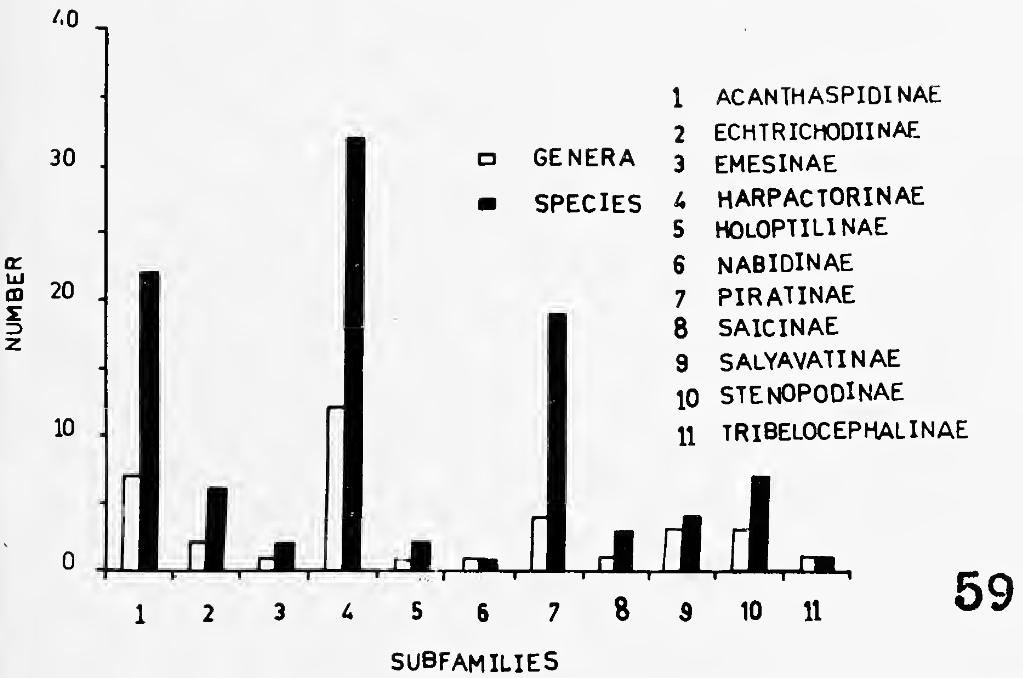

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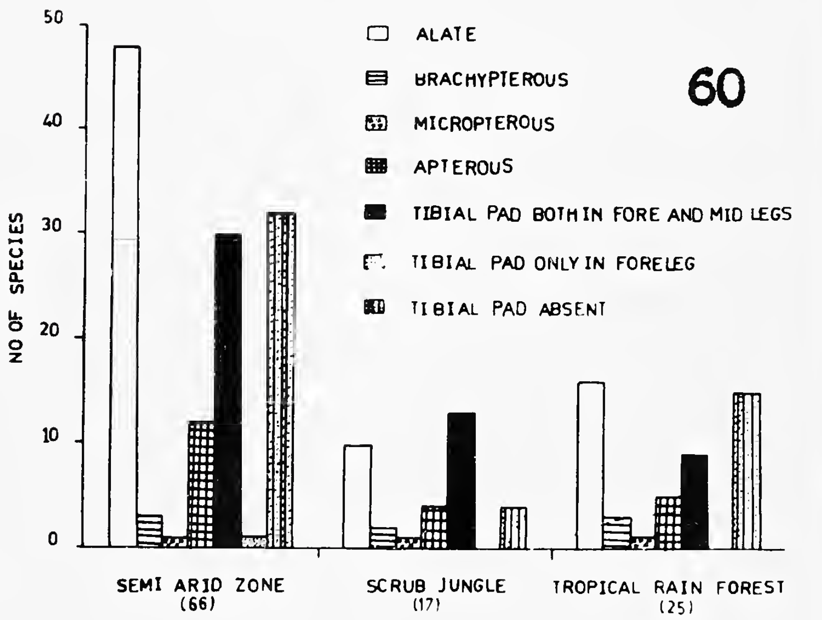

Fig. 55. *Acanthaspis pedestris* feeding on Camponotine ant. Notice the rostral curvature and position of the fore and mid legs; Fig. 56. *Sphedanolestis aterrimus* lifting and feeding on *Cimex hemispteris.* Notice the straight rostrum and the fore and mid legs devoid of tibial pad and let free; Fig. 57. *Rhinocoris marginatus* in the act of oviposition; Fig. 58. Districtwise distribution of Reduviids in the Scrub jungles of Tamil Nadu (S. India); Fig. 59. Familywise distribution of Reduviids in the scrub jungles of Tamil Nadu (S. India); Fig. 60. Coimbatore (Palghat Gap) distribution of Reduviids on the basis of ecomorphological variations.

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A NOTE ON THE DISTRIBUTION OF SOME PLANTS IN GANGANAGAR DISTRICT, RAJASTHAN[1]

B. P. SINGH AND N. S. BRAR[2]

A distribution of 25 taxa in Ganganagar district of Rajasthan has been recorded, the majority of which being reported from the State for the first time.

INTRODUCTION

The district of Ganganagar having an area of 20,629 sq. km is situated in the north of Rajasthan State between 28°40′-30°6′ N. Lat. and 72°36′-75°30′ E. Long. It constitutes a part of the Great Indian Desert. The district is being irrigated by the Gang Canal, Bhakra Canal and Rajasthan Canal which has greatly affected the natural flora of the area in many ways. The irrigation waters which owe their source to the Punjab rivers have been bringing seeds and other propagules of a number of extra-limital species year after year and many of these have already become successfully established in the area as crop weeds or along the banks of canals. The most wonderful example of this naturalization of Himalayan plants in the Great Indian Desert are species of *Riccia, Marchantia* and *Ophioglossum vulgatum* L. (Singh & Brar 1980) which are found frequently in the canal irrigated areas, showing thereby the extent to which plants from the Himalayas and other places have become naturalised in this irrigated desert.

We are presently working on the flora of North Rajasthan and about 500 species are collected and identified. While studying the specimens, we found some of these were not reported previously from Rajasthan (Blatt. & Hallb. 1918-21, Puri *et al.* 1964, Bor 1960, Bhandari 1978, Sharma & Tiagi 1979, Katewa 1979, Aery 1978, Majumdar 1980), therefore, new records for the State. The specimens have been preserved in the Herbarium, Department of Botany, SGN Khalsa College, Sriganganagar (Raj.).

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[2] SGN Khalsa College, Sriganganagar (Raj.).

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EHRETIACEAE

Cordia fulvosa Wight. Icon. Vol. 4, 2 (1850): 15, t. 1380; Cooke II: 267.
Fl. & Fr.: April-June.
Spec. & Loc.: Bhiani nursery; Singh & Brar: 755.
Distribution: India (W. Peninsula).

CUSCUTACEAE

Cuscuta capitata Roxb. Fl. Ind. 1: 448, 1932; FBI 4: 227; Nair 176.
Fl. & Fr.: Nov.-April.
Spec. & Loc.: Padampur; Singh & Brar: 759.
Distribution: A temperate weed, co-distributed with *Medicago sativa*.

OROBANCHACEAE

Orobanche aegyptiaca Pers. Syn. 2: 181, 1807; Cooke 2: 387; Duthie 2: 164; Kashyap 190; Nair 194. *O. indica* Buch.-Ham. in Roxb. Fl. Ind. 3: 27, 1832; FBI 4: 326.

Fl. & Fr.: Jan.-March.
Spec. & Loc.: Padampur; Singh & Brar: 784.
Distribution: Central and Western Asia; India (throughout the plains, especially on *mustard* crops).

POLYGONACEAE

Polygonum lanigerum R. Br. Prodr. 419, 1810, FBI 5: 35; Duthie 3: 34; Nair 231.
Fl. & Fr.: Jan.-June, Oct.-March.
Spec. & Loc.: 'Z' Minor; Singh & Brar: 826.
Distribution: Java, Philippines, Egypt, Tropical and S. America and Africa, Australia, India (Bengal, lower Himalayas, Punjab).

EUPHORBIACEAE

Chrozophora oblongifolia (Del.) A. Juss. Tent. Euphorb. 28, 1824; Kashyap 230; Nair 233.
Croton oblongifolius Del. Fl. Aeg. 139. 1813.
Chrozophora obliqua Juss. *loc. cit.* 28, 1824; FBI 5: 409; Cooke 3: 104; Duthie 3: 105.
Fl. & Fr.: March-Nov.
Spec. & Loc.: Budhajaur; Singh & Brar: 834.
Distribution: Arabia, N. Africa, India (Punjab, Kashmir).

Euphorbia helioscopia Linn. Sp. Pl. 459, 1753; FBI 5: 262; Kashyap 223; Nair 237.
Fl. & Fr.: Feb.-April.
Spec. & Loc.: Govt. nursery; Singh & Brar: 835.
Distribution: Afghanistan, Westwards to Atlantic, Japan, India (Punjab and Western Himalayas).

Euphorbia serpens H. B. K. Nov. Gen. 2 : 52, 1817; Boiss in DC. Prodr. 5(2) : 29, 1862; Mitra in J. Bombay nat. Hist. Soc. 68(3): 825-856, 1972. Raizada Suppl. Fl. UGP 1976.
Fl. & Fr. : Dec.-Jan.
Spec. & Loc.: Botanical Garden; Singh & Brar: 526.
Distribution : Java. India (Bengal, Bihar, Madras, Gangetic plains).
Note. Recently Mitra (1972) has pointed out that the plant which was previously known under the names of *E. microphylla* Heyne or *E. bombaiensis* Santapau or *E. orbiculata* H.B.K. is really *E. serpens* H.B.K.

URTICACEAE

Pouzolzia pentandra (Roxb.) Benn. Pl. Jav. Rar. 67, 1838; FBI 5 : 583; Cooke 3 : 137; Duthie 3 : 132; Kashyap 235; Nair 242. *Urtica pentandra* Roxb. A. Ind. 583, 1832.
Fl. & Fr.: Sept.-Nov.
Spec. & Loc. : Gang Canal; Singh & Brar : 527.
Distribution : Afghanistan, Java, China, India (Dehradun, Tropical Himalayas, Punjab, Assam, Khasia Hills, Bengal, Orissa).

MORACEAE

Morus indica Linn. Sp. Pl. 986, 1753; FBI 5 : 492; Cooke 3 : 159; Duthie 3 : 136; Kashyap 235.
Fl. & Fr. : Jan.-April.
Spec. & Loc.: Sohan Lal Baug; Singh & Brar: 540.
Distribution : Temperate and Tropical regions, India (Outer Himalayas, Sub-Himalaya tracts, Bengal, Nilgiri hills, Punjab).

APONOGETONACEAE

Aponogeton natans (Linn.) Engl. & Krause in Pfreich. 24 : 11, 1906; Nair 256. *Saururus natans* Linn. Mant. 227, 1771. *A monostachyus* Linn. f. Suppl. 214, 1781; FBI 6 : 564.
Fl. & Fr : Sept.-Dec.
Spec. & Loc. : Gang canal; Singh & Brar : 549.
Distribution : Warm regions from India and S. China through Malaya to Australia, dominant in Tropical and S. Africa and Madagascar.

POACEAE

Aristida plumosa Linn. Sp. Pl. ed. 2, 2: App. 1666; FBI 7 : 228; Bor 411.
Fl. & Fr. : Aug.-Oct.
Spec. & Loc. : 58 GB; Singh & Brar : 573.
Distribution : Mediterranean region, Pakistan, Afghanistan, North-west India.

Catabrosa aquatica (Linn.) P. Beauv. Ess. Agrost. 97, t. 19, f. 8, 1812; FBI 7: 310; Bor 528. *Aira aquatica* Linn. Sp. ed. 1, 64, 1753.
Fl. & Fr. : Aug.-Oct.
Spec. & Loc. :Lyallpur garden; Singh & Brar : 853.
Distribution : Europe, Temperate Asia and North America.

Dichanthium odoratum (Lisboa) Jain et Deshpande in Bull. bot. surv. India 20 : 133-135, 1978. *Andropogon odoratus* Lisboa in JBNHS 4 : 123, 1889.
Fl. & Fr. : Throughout the year.
Spec. & Loc. : Gang Canal; Singh & Brar : 904.
Distribution : Bombay State, apparently endemic.

Digitaria bicornis (Lamk.) Roem. *et* Schult. *ex* Laud., Hort. Bril. 24, n. 1578, 1830; Bor 299. *Paspalum bicorne* Lamk., Tab. Encycl. Math. Bot. 1 : 176, 1791.
Fl. & Fr. : Sept.-Dec.
Spec. & Loc. : Kola Forest; Singh & Brar : 584.
Distribution : Tropical Asia.

Digitaria stricta Roth *ex* Roem. *et* Schult., Syst. Veg. 2 : 474, 1817; Bor 305.
Fl. & Fr. :Rainy season.
Spec. & Loc. : College campus; Singh & Brar : 592.
Distribution: Tropical Asia, including many parts of India, Burma, Ceylon.

Diplachne fusca (Linn.) P. Beauv. Ess. Agrost. 80, 163, 1812; FBI 7 : 329; Bor 492.
Fl. & Fr. : Sept.-Jan.
Spec. & Loc. : River sides; Singh & Brar : 854.
Distribution : Cosmopolitan.

Eragrostis nutans (Retz.) Nees *ex* Steud. Nom. Bot. ed 2 : 563, 1840; Bor 511. *Poa nutans* Retz. Obs. Bot. 4 : 19, 1796.
Fl. & Fr. : Aug.-Oct.
Spec. & Loc. : Gang Canal; Singh & Brar : 862.
Distribution : India (Madras, Bihar)

Koeleria argentea Griseb. in Goett. Nachr. 77, 1868; FBI 7 : 309; Bor 444.
Fl. & Fr. : Aug.-Oct.
Spec. & Loc. : Tibbi; Singh & Brar : 594.
Distribution : Alpine Regions of Tibet, and the Himalayas.

Leptochloa chinensis (Linn.) Nees in Syll. Ratisb. 1: 4, 1824; Bor 516. *Poa chinensis* Linn. Sp. Pl. ed. 1, 69, 1753.
Fl. & Fr. : Aug.-Oct.
Spec. & Loc. : Local gardens; Singh & Brar : 865.
Distribution : South-east Asia.

Lophochloa phleoides (Vill.) Reichb. Fl. Ger. Excurs. 42, 1830; Bor 445; Maheshw. 402; Nair 283. *Festuca phleoides* Vill. Fl. Delph. 7, 1785.
Fl. & Fr. : Feb.-March.
Spec. & Loc. : College campus; Singh & Brar : 870.
Distribution : From Europe and the Mediterranean region. India (Punjab).

Panicum austroasiaticum Ohwi in Act. Phytotax. *et* Goebot. 2 : 1, 45, 1942; Bor. *P. humile* Nees *ex* stud. Syn. Gram. 84; FBI 7 : 48.
Fl. & Fr. : Jul.-Oct.
Spec. & Loc. : Govt. nursery; Singh & Brar : 601.
Distribution : Tropics of South-east Asia, also in North Tropical Africa.

Panicum repens Linn. Sp. Pl. ed. 2: 87, 1762; Bor 330. *P. ischaemoides* Rate. Obs. Bot. 4 : 17, 1786.
Fl. & Fr. : Sept.-Oct.
Spec. & Loc. : Lyallpur garden; Singh & Brar : 602.
Distribution : Tropical and subtropical areas of both hemispheres.

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Spec. & Loc. :College campus : Singh & Brar : 871.
Distribution : India and East Tropical Africa.

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Fl. & Fr. :Dec.-March.
Spec. & Loc. : Padampur; Singh & Brar : 876.
Distribution : Ceylon, most warm countries, throughout India.

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Fl. & Fr. : Aug.-Nov.
Spec. & Loc.: Karanpur; Singh & Brar: 907.
Distribution : Pakistan (Sind), India.

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BREEDING BIOLOGY OF THE INDIAN FRUIT BAT, *CYNOPTERUS SPHINX* (VAHL) IN CENTRAL INDIA[1]

SATWANT SANDHU[2]

(*With a text-figure*)

Cynopterus sphinx (Vahl) breeds twice in the year in quick succession in central India, and brings forth one young during each cycle. The cycle commences in October-November and deliveries in the colony take place during the following February-March. The females become pregnant within a short time after parturition and carry the second pregnancy until June-July. The second pregnancy cycle overlaps the lactation period of the first cycle. The young one is carried by the mother for about 45 to 50 days. In the first cycle, the right side of the female genitalia is physiologically dominant, and the persistance of a large corpus luteum in the right ovary necessitates the left ovary to release the ovum in the second cycle. Although the sex ratio is balanced at birth, there is an uneven female dominant sex ratio in the total population due to the preferential mortality of the males during juvenile life. Whereas the females attain sexual maturity within five months of age, the males do not reach sexual maturity until they are at least 15 months of age.

INTRODUCTION

It is evident from the few casual observations of earlier workers that Indian megachiropterans differ considerably from their counterparts in other parts of the world in regard to their reproductive habits. The two brief reports, which are available on two species of *Cynopterus,* also point to this feature. Ramakrishna (1947) briefly mentioned that females of *Cynopterus sphinx sphinx* experienced post-partum pregnancy at and around Bangalore. Moghe (1956), while describing the embryology of *Cynopterus sphinx gangeticus* around Nagpur, made a casual reference to the possibility of occurrence of two pregnancies in a year in this species. Details of the reproductive cycles were not given by either of the authors. The absence of any detailed study on the reproductive physiology of *Cynopterus sphinx* (Vahl) in central India prompted me to undertake a detailed study of the sex cycle of this bat. The present report embodies the general pattern of reproduction and observations on some associated phenomena in this species.

HISTORICAL

The first ever detailed study on the reproduction of any megachiropteran bat was made by Baker & Baker (1936) on *Pteropus geddeii* and *Pteropus eotinus* from New Hebrides 4° north of the Equator. The authors showed that these species breed in a season corresponding to the southern autumn like most bats in both the hemispheres and on the basis of this as well as on the basis of their studies of reproduction of some microchiropteran species (Baker & Bird 1936) they not only emphasised the fact that these bats have a strictly defined

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reproductive periodicity even though inhabiting an almost unvarying tropical climate in a rain forest, but that the biological equator is different from the geographical equator, the former being approximately 4° north of the latter.

Eidolon helvum inhabiting squarely on the equator in Africa mates in a sharply restricted season in the year, but there is a very long period of delayed implantation when the blastocyst lies freely in the uterus without undergoing further development (Mutere 1967, 1968).

The above descriptions have indicated that the Megachiroptera copulate in autumn and deliver the young in the following spring — a situation common to bats inhabiting temperate and cold climates. However, the Indian megachiropteran bat, *Rousettus leschenaulti* (Gopalakrishna & Choudhuri 1977) at and around Aurangabad, Maharashtra appears to have combined in it the autumn breeding pattern of the temperate bats and the spring breeding pattern of the tropical bats by breeding twice in the year. There are, however, conflicting reports on the reproduction of *Pteropus giganteus giganteus.* Whereas this species breeds in a sharply restricted season in Ceylon (Sri Lanka) with copulations occurring during the period corresponding to northern autumn and deliveries in the following spring (Marshall 1947) [although at Ceylon (Sri Lanka) these seasons are not well defined], this species has an anomalous breeding pattern in central India (Moghe 1951, Gopalakrishna & Sahasrabudhe 1972) without a sharply defined season of copulation or delivery. On any given date different females carry embryos at different stages of development, and deliveries in the colony occur during nearly all the months of the year except probably during October to December, and there is no evidence of the occurrence of more than one pregnancy per year in each female.

The works of Ramakrishna (1951), Gopalakrishna (1954), Ramaswamy (1961), Gopalakrishna & Madhavan (1978), Ramakrishna & Rao (1977) and Gopalakrishna & Rao (1977) on several species of bats from different regions of India have revealed that different species exhibit different breeding behaviour under different ecological situations. Since some information (inadequate though) is available on the occurrence of post-partum pregnancy in *Cynopterus sphinx sphinx* (Ramakrishna 1951) at Bangalore, the present studies on the reproduction of *Cynopterus sphinx* (Vahl) at and around Nagpur have been carried out with a view to finding out if cynopterid bats have a common pattern of reproduction in different climatic conditions.

Material and Methods

Specimens of *Cynopterus sphinx* (Vahl) were collected at Nagpur, Maharashtra State, India at frequent intervals for two years commencing on 24th January, 1982 such that every calendar month is represented by several collections. Altogether 601 specimens were examined for the present report. The animals were shot down with an air rifle and the body weight of each specimen was recorded by a sensitive spring balance.

After noting down the nature of the external genitalia and the condition of the mammary glands and nipples of each female, the specimens were dissected and their genitalia and accessory reproductive structures were fixed in various ways such as in neutral formalin, Bouin's, Rossman's and Zenker's fixatives. The mammary glands of the females were also fixed likewise. After fixation for 24 hours the tissues were stored in 70% ethanol for further

TABLE 1

DATEWISE DETAILS OF COLLECTIONS OF *Cynopterus sphinx* (VAHL)

Date	Males				Females									Total of males & females
	Immature		Adults	Total	Immature		Adults						Total	
	Attached	Free			Attached	Free	Non-pregnant		Pregnant					
							Non-lacta-ting	lacta-ting	Non-lactating		Lactating			
									Right cornu	Left cornu	Right cornu	Left cornu		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6-1-83	–	–	1	1	–	–	–	–	3	–	–	–	3	4
8-1-83	–	4	1	5	–	–	–	–	1	–	–	–	1	6
10-1-83	–	–	1	1	–	–	–	–	1	–	–	–	1	2
12-1-83	–	1	–	1	–	–	–	–	1	2	–	–	3	4
17-1-83	–	1	–	1	–	–	–	–	3	–	–	–	3	4
21-1-83	–	1	–	1	–	–	–	–	3	1	–	–	4	5
23-1-84	–	–	1	1	–	–	–	–	3	1	–	–	4	5
24-1-82	–	–	1	1	–	–	–	–	1	1	–	–	2	3
25-1-82	–	–	–	–	–	–	–	–	3	–	–	–	3	3
31-1-82	–	–	1	1	–	–	–	–	1	–	–	–	1	2
2-2-82	–	–	–	–	–	–	–	–	2	–	–	–	2	2
3-2-82	–	–	1	1	–	–	–	–	2	1	–	–	3	4
3-2-83	–	1	1	2	–	–	–	–	3	1	–	–	4	6
4-2-82	–	–	1	1	–	–	–	–	2	1	–	–	3	4
6-2-82	–	1	2	3	–	–	–	–	1	1	–	–	2	5
7-2-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
9-2-82	–	–	4	4	–	–	1*	–	–	–	–	–	1	5
12-2-82	–	–	3	3	–	–	–	–	–	1	–	–	1	4
16-2-82	1	–	1	2	–	–	–	1	–	1	–	–	2	4
18-2-82	–	–	1	1	–	–	–	–	–	–	–	–	–	1
19-2-82	–	–	3	3	–	–	–	–	2	–	–	–	2	5
20-2-82	–	–	1	1	2	–	–	2	1	–	–	–	5	6
21-2-82	–	–	3	3	1	–	–	1	1	1	–	–	4	7

TABLE 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
23-2-82	1	–	–	1	–	–	–	1	1	1	–	–	3	4
23-2-83	–	1	3	4	1	–	–	1	1	1	–	–	4	8
24-2-82	2	–	1	3	–	–	–	2	1	–	–	–	3	6
25-2-82	1	–	2	3	1	–	–	2	–	–	–	–	3	6
3-3-82	–	–	–	–	1	–	–	1	–	–	–	–	2	2
4-3-82	–	–	1	1	2	–	–	2	–	–	–	–	4	5
7-3-82	–	–	2	2	1	–	–	1	–	–	–	1	3	5
11-3-82	–	2	–	2	–	–	–	–	–	–	–	–	–	2
12-3-82	2	1	4	7	1	–	–	–	–	1	1	–	3	10
12-3-83	1	–	2	3	2	–	–	3	–	–	–	–	5	8
14-3-82	1	–	–	1	1	–	–	–	–	–	–	1	2	3
18-3-82	–	–	1	1	1	–	–	–	–	–	–	1	2	3
19-3-82	–	–	1	1	1	–	–	–	–	–	–	1	2	3
20-3-82	2	1	–	3	1	–	–	–	–	–	2	1	4	7
20-3-83	1	1	1	3	–	–	–	1	–	–	1	1	3	6
22-3-82	–	–	1	1	2	–	–	–	–	–	–	3	5	6
24-3-82	1	1	–	2	1	–	–	–	–	–	1	1	3	5
25-3-82	1	1	–	2	1	–	–	–	–	1	1	1	4	6
27-3-82	–	1	2	3	2	–	–	–	–	–	1	1	4	7
28-3-82	1	–	1	2	–	–	–	–	–	–	–	1	1	3
30-3-82	1	1	–	2	–	–	–	–	–	–	2	–	2	4
2-4-82	2	–	1	3	–	–	–	–	–	–	–	2	2	5
4-4-82	2	–	1	3	–	–	–	–	–	–	1	2	3	6
6-4-82	–	–	–	–	2	1	–	–	–	–	2	1	6	6
9-4-82	1	–	–	1	1	–	–	–	–	–	–	2	3	4
11-4-82	1	–	1	2	–	2	–	–	–	–	1	2	5	7
14-4-82	1	1	–	2	1	–	–	–	–	–	–	3	4	6
14-4-83	1	1	2	4	1	2	–	–	–	–	–	1	4	8
16-4-82	1	–	–	1	–	–	–	–	–	–	–	1	1	2
17-4-82	–	–	–	–	–	1	–	–	–	–	1	3	5	5
25-4-82	–	–	1	1	–	–	1*	–	1	–	–	–	2	3
26-4-82	–	1	1	2	–	1	–	–	–	–	–	2	3	5
26-4-83	2	–	–	2	–	–	–	–	–	–	–	3	3	5
29-4-82	–	2	–	2	–	1	–	–	–	–	–	2	3	5
2-5-83	–	–	1	1	–	2	–	–	–	–	–	1	3	4
3-5-82	1	–	–	1	–	–	–	–	–	2	1	2	5	6
8-5-82	–	2	1	3	–	–	–	–	–	–	–	–	–	3

TABLE 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
9-5-83	–	1	1	2	–	1	–	–	–	2	–	–	3	5
11-5-82	–	3	1	4	–	2	–	–	–	1	1	–	4	8
20-5-83	–	2	–	2	–	1	–	–	1	1	–	–	3	5
28-5-83	–	1	1	2	–	–	–	–	–	4	–	–	4	6
4-6-83	–	5	–	5	–	–	–	–	–	2	–	–	2	7
11-6-83	–	2	1	3	–	2	–	–	–	1	–	–	3	6
15-6-83	–	–	2	2	–	–	–	–	1	–	–	–	1	3
21-6-83	–	–	2	2	1	–	–	1	1	–	–	–	3	5
22-6-82	–	–	–	–	–	–	1	–	2	–	–	–	3	3
23-6-83	2	–	1	3	–	–	–	2	–	1	–	–	3	6
27-6-83	–	2	1	3	–	–	–	–	–	–	–	–	–	3
28-6-83	–	–	–	–	2	–	–	2	–	–	–	–	4	4
29-6-82	–	–	–	–	–	–	1	–	1	–	–	–	2	2
3-7-83	–	3	–	3	1	–	–	1	–	–	–	–	2	5
7-7-82	1	2	1	4	–	–	1	1	–	–	–	–	2	6
9-7-83	–	1	1	2	–	–	–	1	–	–	2	–	3	5
13-7-82	–	2	1	3	1	–	–	1	–	–	–	–	2	5
15-7-83	2	–	–	2	1	–	–	3	–	–	–	–	4	6
16-7-83	1	2	2	5	–	2	–	1	–	–	–	–	3	8
17-7-82	–	1	–	1	–	1	–	–	–	1	–	–	2	3
22-7-82	–	–	–	–	2	–	–	2	–	–	–	–	4	4
22-7-83	1	–	1	2	–	–	1	2	–	–	–	–	3	5
1-8-82	–	1	–	1	2	–	–	2	–	–	–	–	4	5
3-8-83	3	1	–	4	1	–	–	4	–	–	–	–	5	9
8-8-82	1	–	–	1	–	1	–	1	–	–	–	–	2	3
11-8-83	1	–	–	1	–	–	1	2	–	–	–	–	3	4
18-8-82	–	–	–	–	2	1	–	2	–	–	–	–	5	5
21-8-83	1	–	1	2	–	–	–	2	–	–	–	–	2	4
26-8-82	1	2	1	4	–	–	–	1	–	–	–	–	1	5
3-9-83	–	1	1	2	–	–	–	–	–	–	–	–	–	2
5-9-82	–	–	2	2	–	–	–	2	–	–	–	–	2	4
9-9-83	–	–	–	–	–	–	2	–	–	–	–	–	2	2
14-9-82	–	1	1	2	–	–	–	1	–	–	–	–	1	3
17-9-83	–	1	–	1	–	–	2	–	–	–	–	–	2	3
21-9-82	–	–	2	2	–	–	–	2	–	–	–	–	2	4

TABLE 1 (contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
21-9-83	–	1	–	1	–	–	1	1	–	–	–	–	2	3
24-9-83	–	2	1	3	–	–	–	–	–	–	–	–	–	3
30-9-83	–	–	2	2	–	–	1	2	–	–	–	–	3	5
3-10-83	–	1	–	1	–	–	2	–	–	–	–	–	2	3
5-10-82	–	1	2	3	–	–	–	–	–	–	–	–	–	3
9-10-83	–	–	2	2	–	–	3	–	–	–	–	–	3	5
12-10-82	–	2	1	3	–	–	1	–	–	–	–	–	1	4
16-10-83	–	1	5	6	–	–	3	–	–	–	–	–	3	9
22-10-82	–	3	1	4	–	–	1	–	2	–	–	–	3	7
22-10-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
30-10-82	–	3	2	5	–	–	–	–	1	1	–	–	2	7
31-10-83	–	3	3	6	–	–	–	–	–	–	–	–	–	6
3-11-82	–	1	2	3	–	–	1	–	1	–	–	–	2	5
7-11-83	–	1	1	2	–	–	–	–	1	1	–	–	2	4
11-11-82	–	1	2	3	–	–	–	–	1	2	–	–	3	6
14-11-82	–	–	1	1	–	–	–	–	4	–	–	–	4	5
16-11-83	–	3	3	6	–	–	–	–	1	–	–	–	1	7
18-11-82	–	1	2	3	–	–	–	–	3	–	–	–	3	6
23-11-82	–	2	1	3	–	–	–	–	1	–	–	–	1	4
26-11-82	–	4	2	6	–	–	–	–	1	–	–	–	1	7
29-11-83	–	2	–	2	–	–	–	–	1	–	–	–	1	3
30-11-82	–	–	–	–	–	–	–	–	4	–	–	–	4	4
3-12-82	–	1	–	1	–	–	–	–	–	–	–	–	–	1
5-12-82	–	1	3	4	–	–	–	–	5	1	–	–	6	10
11-12-83	–	4	1	5	–	–	–	–	–	1	–	–	1	6
14-12-82	–	2	–	2	–	–	–	–	–	1	–	–	1	3
19-12-82	–	2	4	6	–	–	–	–	–	2	–	–	2	8
22-12-83	–	3	1	4	–	–	–	–	2	–	–	–	2	6
26-12-82	–	1	–	1	–	–	–	–	2	1	–	–	3	4
28-12-82	–	1	–	1	–	–	–	–	2	–	–	–	2	3
31-12-83	–	1	1	2	–	–	–	–	–	–	–	–	–	2
Total	42	110	127	279	40	21	22	57	79	44	19	40	322	601

*Adult specimens had undergone abortion.

TABLE 2

MONTHWISE COLLECTION OF SPECIMENS

Month	No. of males	No. of females	Total
January	13	25	38
February	37	44	81
March	36	49	85
April	23	45	68
May	15	22	37
June	18	21	39
July	22	25	47
August	13	22	35
September	15	14	29
October	32	16	48
November	29	22	51
December	26	17	43
Total	279	322	601

processing. In the case of males the right testis and the right epididymis of each specimen were weighed with a Mettler balance after gently rolling the organs on a filter paper. While this does not give the exact weight of these organs, this method gives accurate relative values of the organs of the animals since the error due to fixation and preservation is same for all animals. The testis and accessory reproductive organs in the males and the ovaries, uterine cornua, vagina and mammary glands of the females were dehydrated by passing through graded ethanol, cleared in xylol, embedded in paraffin and cut at 8 to 10 μ thickness. For routine histological study the tissues were stained with Ehrlich's or Harris's haematoxylin and counterstained with eosin. Selected sections from each series were stained by the periodic acid-Schiff procedure (Pearse 1968), some by Mallory triple procedure and some by Heidenhain's Azan technique. All microscopic measurements were taken with the help of an ocular micrometer calibrated to a stage micrometer.

A detailed field diary and laboratory record have been maintained. Table 1 gives the datewise details of the collections and Table 2 gives the monthwise collections of the specimens.

OBSERVATIONS AND DISCUSSION

A. *General remarks*

This species normally roosts in the space formed by groups of downward hanging, dried-up fronds of palm trees. The specimens emerge from their roosts about half an hour after sunset when there is still some twilight. Normally the specimens do not return to the roost until after feeding. However, during April and May the females were noticed to return now and then probably to give suck to the unweaned free young ones, which had been left behind in the roost, while the mothers went out foraging. This contention received additional support from the fact that many a female which was shot during April and May was in lactation, but had no young at their breasts.

An interesting feature about the roosting habits of these bats is that normally adult males roost separately from the females, and usually solitarily and rarely in groups of two or three except during the season of copulation. In fact, whenever a single specimen was noticed inside the hollows among the dried fronds, it was invariably a male. Juvenile males were, however, present among the females throughout the year.

Several newly delivered young ones were obtained during February to April and June and July — the two periods of delivery for this species The average weight of the young one at delivery was 11 g and this was also the average weight of the full term foetus. The young one gets a firm hold of one of the

mammary nipples of the mother soon after it is delivered. The teeth of the young were so firmly and deeply sunk in the wall of the nipple that it required considerable force to separate the young one from the mother although the latter was dead and the young was still alive. The young one is constantly carried by the mother even during flight for about 45 to 50 days by which time the young one reaches a body weight of 34 to 36 g. No young one above this weight was noticed to be adhering to the mother's nipple. Evidently, the young ones leave their mothers after attaining this weight, but continue to suck milk for some more days before they are finally weaned. This fact also suggests that there is community suckling for some time after the young ones leave the breast of their mothers since it is unlikely that the young ones are able to find out their own mothers after getting free and *vice-versa.* On a few occasions there were two young ones attached one to each nipple of the mother. Obviously, one of the young could not be belonging to the mother since invariably only a single foetus is borne by each mother during each cycle.

B. *Female genitalia*

Externally the female genital organs of *Cynopterus sphinx* are built on a typically bicornuate plan. The two uterine cornua are of equal size in the non-pregnant female and form a 'V' shaped structure, the two limbs of the 'V' forming an angle of about 60°. In adult specimens each cornu is 8-10 mm long. The Fallopian tube arises from the posterio-median aspect of the ovarian bursa adjacent to a slit-like opening of the bursa, and, after taking a simple loop around the cranial aspect of the ovarian bursa, opens a little behind the cranial tip of the uterus on each side. The vagina is 12 to 14 mm long and gives the female genitalia a 'Y' shaped appearance, the vagina forming the vertical limb of the 'Y'. The vulval opening is a transverse slit and occurs on a thick pad slightly elevated from the surface of the body. On sectioning, it becomes evident that the uterine cornua remain separate and there are two distinct cervical canals on the lateral sides of the long cervix which projects to about half the length of the vagina. The cervical canals open independantly subterminally on the two sides of the cervix. The cranial three-fourths of the cervix is attached to the dorsal wall of the vagina. Hence, the vagina appears to be partitioned into two chambers for some distance and the vaginal canal appears like a semi-circular cavity surrounding the cervix in transverse sectional views.

The mammary glands are located on the ventro-lateral sides of the thorax just a little posterior to the axilla. The nipples project laterally. During lactation each mammary gland extends almost to the axilla of the respective side. The nipples become extended and cornified during the first lactation ofter which they do not regress completely. Hence, even during the non-pregnant season the parous females can be distinguished from the non-parous ones by the nature of the mammary nipples.

C. *Breeding seasons*

Since the reproductive stage of the animals was the same during the two years when the animals were collected, only the date and the month are mentioned in the following descriptions except where the mention of the year is warranted by some special condition. The examination of Table 1 and the collection diary reveals that each female specimen experiences two pregnancies in quick succession, the first pregnancy occurring during October to March, and the second pregnancy, which overlaps the

lactation period of the first pregnancy, commences within a short period after parturition and continues until June-July. The period from July to October is the sexually quiescent anoestrous period. Not all the females in the colony conceive at the same time during the first cycle, and this is also reflected in the second cycle since deliveries do not occur synchronously in all the females. Hence, conceptions after parturition in February-March also occur on different days in different specimens in the colony. Hence, during any date or month the females were at different stages of gestation during both the cycles.

The second pregnancy is carried by the uterine cornu contra-lateral to that which carried the first pregnancy. This is evident from the fact that there were several females, in which, whereas one uterine cornu had not yet undergone complete involution, the contralateral cornu carried the foetus of the second cycle. Microscopic examination of the ovaries revealed that a large corpus luteum occupying almost the whole ovary persisted for a few days after delivery in February-March. This necessitated the production and release of the Graafian follicle in the opposite ovary. The corpus luteum of the second cycle also persisted for a few days after parturition in June-July and had undergone regression quickly thereafter. Hence, by the time the young one is weaned the two ovaries present the same histological picture after July, and follicles continue to develop in both the ovaries.

During each pregnancy cycle one of the uterine cornua carries a single embryo. Hence, a single young one is delivered each time. Two females with unmistakable pregnancy, as evidenced by the occurrence of a slightly swollen right uterine cornu in each, were obtained on 22nd October. From the stage of development of the embryo it was evident that the animals had conceived three or four days earlier. After this date more and more females in the colony had conceived. Every female in all the colonies was pregnant during January and February, but the embryo in the uterus varied in the stage of development in different specimens. This is as expected because the date of conception differed in different animals. The first delivered young one was obtained on 16th February, after which more and more females delivered their young. Evidently, gestation lasts for about 120 days allowing a margin of three or four days on either side. The last delivered young one of the first cycle was collected on 20th March. This specimen must have been conceived between 15th and 20th November of the previous calendar year taking the gestation period as being about 120 days.

The earliest second conception was noticed on 20th February, and the first newly born young of the second cycle was obtained on 21st June. This was probably one or two days old. This also gives a gestation period of about 120 days. The last date on which a newly born young of the second cycle was 16th July, and this must have been conceived about the middle of March.

The first free young weighing 34g was collected on 6th April. Assuming that this belonged to the group delivered in the first batch (that is, on 16th February), it becomes evident that this specimen was about 50 days old. However, the females continue to be in lactation for another 10 to 15 days more during which period the free young onces probably take suck periodically.

Examination of Table 1 reveals that, whereas during the first cycle 71 females among 99 carried the conceptus in the right cornu of the uterus, in the second cycle only 27 females among 81 carried the conceptus in the right

cornu. Further, in most of the females collected during February and March, while one cornu was still in the post-partum condition and had not completely involuted, the contralateral cornu carried an embryo. These facts taken along with the fact that a large corpus luteum of the first cycle persists for a few days after delivery and during early pregnancy of the second cycle suggest that there is a distinct alternation of the two sides of the female genitalia in the two cycles in the year. However, within a short time after parturition in June-July the two ovaries present a typically anoestrous condition. Microscopic examination of the two ovaries of the adult specimens and the non-parous females approaching their first cycle during August and September revealed that numerous follicles at various stages of development were present in both the ovaries. However, in most of the females collected during October the right ovary had distinctly outstripped the left in the development of the Graafian follicles. In both the ovaries the follicles develop concurrently up to the vesicular stage, but after this stage the development of the follicles becomes arrested in the left ovary in most of the specimens, and one of the follicles in the right ovary develops further and releases the ovum. This is why a large proportion of the females carry the concept in the right ovary in the first cycle during each year. The persistence of the corpus luteum of the first cycle for a few days after parturition necessitates the alternation of the two sides of the female genitalia during the two cycles in the year. Hence, in the second cycle there were more females carrying the embryo in the left uterus than the right and the relative proportion is nearly the reverse of the proportion of pregnancy in the two sides during the first pregnancy cycle.

D. *Growth and maturity*

The following descriptions pertain to the females only. It has already been shown that the newly born young one weighs about 11 g, and they are weaned when they attain a body weight of about 35 g about 40 to 45 days after birth. Figure 1 is a scatter diagram to show the body weight of the females collected on different dates, and the lines are drawn to indicate the growth rate. The females reach sexual maturity when they attain a weight of about 50 g — this being the lowest weight of a female carrying an early embryo in the uterine cornu. The growth curves indicate that the specimens born in February-March, reach this weight by July-August, that is about five months after birth, attain sexual maturity by the time of the onset of the breedin season in October. Hence, these females conceive in October along with parous females. The females born in June-July also reach sexual maturity in November-December, when they are five months of age. These copulate and conceive in November-December. This was why there were a few-non-parous females in the colonies during October-November and there was not a single non-pregnant female available after November every female in the colony having conceived by this time. This also explains why different females were at different stages of pregnancy during January-March, and why parturition was not synchronous in all the females.

The growth pattern of the males and the age at sexual maturity have already been described (Gopalakrishna & Sandhu, *in press*). It has been shown that the males do not reach sexual maturity until they are at least 15 to 16 months of age for those animals delivered during February-March and about 19 to 20 months of age in the case of the animals born during June-July.

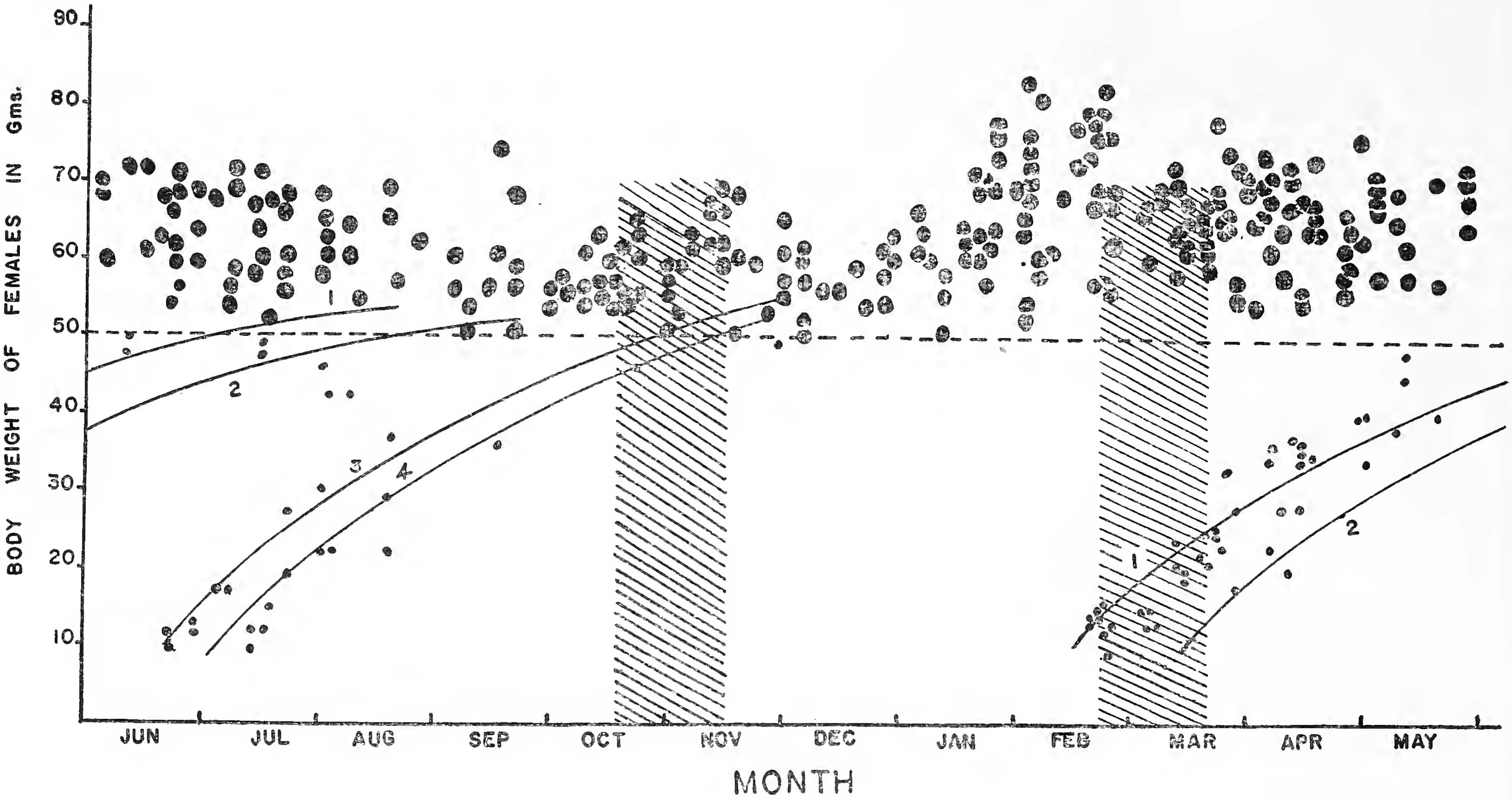

Fig. 1. Scatter diagram in which the body weights of the females are plotted against the dates of collection of the specimens. The dotted line indicates the body weight at sexual maturity. The curves indicate the manner of growth of the animals born during the two breeding cycles. Curves 1 and 2 relate to animals born on the earliest and the latest dates respectively in the first cycle (February-March). Curves 3 and 4 relate animals born in the second cycle (June-July). The shaded areas represent the periods when conception takes place. It is evident from the figure that animals born in February-March and also those born in June-July experience their first conception during October-November along with parous animals.

The fact that the number of young ones in the total population is so small indicates that there is considerable pre-pubertal mortality in this species. On several occasions, young ones with body weights ranging from 17 to 33 g had become accidentally freed from their mothers. These helpless young ones are an easy prey to predators like crows and hawks during the day time and owls and other nocturnal birds during the night.

E. *Sex Ratio*

Table 1 gives the data concerning the sex ratio of *Cynopterus sphinx* at different periods of life. From the table it is seen that among the 601 specimens studied during two years, when frequent random collections were made, 279 were males and 322 females. This gives a clear female-dominant sex ratio of 871 males to 1000 females in the total population. Among the 82 sucklings there was an almost equal number of males and females (42 and 40 respectively). Among 388 sexually mature adults there were 127 males and 261 females, giving a spectacular uneven sex ratio with

32.8% males and 67.2% females. However, in the pre-pubertal stage, not inclusive of the sucklings, the males far outnumber the females (110 males to 24 females). This is because of the difference in the age of attainment of sexual maturity between the two sexes. Whereas the females attain sexual maturity within 5 to 6 months of age, the males take at least 15 to 20 months to reach sexual maturity. Evidently, the overall female dominant sex ratio in the total population is due to a preferential mortality of the males during the growth period. On the basis of the present status of our knowledge it is not possible to assign any specific reason for the occurrence of uneven female dominant sex ratio among all the species of bats so far studied (Gopalakrishna & Madhavan 1978) except *Taphozous melanopogon* (Abdulali 1952). Probably genetic factors are responsible for making the males more susceptible to infection and diseases than the females thereby resulting in establishing an uneven female dominant sex ratio.

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BIRDS OF A POLLUTED RIVER[1]

PRAKASH GOLE[2]

(*With four text-figures & three maps*)

The Mutha river meanders through Pune City for a distance of over 6.5 km from Vitthalwadi to the Southwest, to the Sangam in the northeast, before it merges into the Mula at the latter place. The joint stream then flows for a distance of 4 kilometres before it leaves the city-limits.

I have been watching birds along these stretches of the rivers for well over fifteen years, i.e. since the mid-sixties. This article however, while taking note of some of the major changes noted over all these years, is primarily based on systematic observations made over a period of over six months, i.e. from October 1982 to April 1983.

Special mention should be made of the tail-end portion of the Mula-Mutha, where the joint stream leaves the city-limits. This 1.5 km stretch of the Mula-Mutha now constitutes the Mula-Mutha Bird Sanctuary inaugurated by Dr. Sálim Ali in 1977. The Sanctuary deserves separate treatment on account of the numbers and variety of birds found there in winter and spring.

QUALITY OF RIVER-WATERS

It is generally believed that the water of both the rivers is polluted. Sewage overflows into the rivers at many points and industrial effluents also drain into the rivers. To gauge the extent of pollution, water-samples were collected at many points along the river-course. For chemical analysis of water a five-litre sample was collected from each of the points and 250 cc samples were used for the MPN count. Tables 1A and 1B show results of the analysis of water-samples. The names of collection points are also given in the tables and the same can be seen on maps. To compare the quality of water of the rivers with that of other water-bodies, samples were also collected from the Khadakwasla reservoir upstream on the river Mutha and from Ambil Odha, a stream that meets the Mutha in the city.

It will be seen from Table 1A that as the river flows from Vitthalwadi to the Sangam the proportion of solids, Dissolved solids, COD, BOD and Chlorides goes on increasing which indicates that the river is receiving higher and higher loads of organic matter. This is due to the increase in the number of sewage overflows going into the river. The oxygen content is mostly low. The water of Ambil Odha which flows through densely populated areas and on whose banks a number of hutment colonies are located, brings into the river even greater loads of pollution. It is also worth noting that samples from the Mula and the Mula-Mutha also show a higher concentration of pollution and compare favourably with the Odha.

Table No. 1B shows the results of the MPN count. Predictably the analysis shows an in-

[1] Accepted May 1983.

[2] 1B Abhimanshree Housing Society, Pune 411 008, Maharashtra.

TABLE 1A

CHEMICAL AND BACTERIOLOGICAL ANALYSIS OF WATER SAMPLES COLLECTED AT DIFFERENT POINTS ALONG THE RIVERS IN PUNE CITY

	No. of Collecting Stations along the Mutha, the Mula & the Mula-Mutha										
Count of	1	2	3	4	5	6	7	8	9	10	Names of Stations
Turbidity (ppm)	07	16	06	12	11	09	14	11	08	15	1 = Khadakwasla Reservoir
Total Solids (mg/litre)	108	120	100	168	184	200	252	322	190	334	2 = Upstream of Vitthalwadi
Dissolved Solids (mg/l)	108	108	100	148	167	191	246	218	180	292	3 = Opp. Pumping Station
COD	10	04	24	25	21	05	78	70	19	150	4 = Upstream of Garware Causeway
BOD	03	01	07	07	06	02	30	22	07	40	5 = Near Shinde Bridge
Dissolved Oxygen	4.20	1.40	4.60	4.20	5.20	4.30	2.90	2.40	1.30	3.0	6 = Upstream Dengle Bridge
Nitrates (N205)	—	—	—	—	—	—	—	—	—	2	7 = Downstream Holkar Br. (on the Mula)
Nitrites (N203)	—	—	—	—	—	—	—	—	—	—	8 = Downstream Sangam Br. (on the Mula-Mutha)
Chlorides (Cl)	14	8	21	21	21	28	35	42	49.5	35	9 = In Bird Sanctuary
											10 = In Ambil Odha

TABLE 1B

BACTERIOLOGICAL COUNT OF WATER COLLECTED AT DIFFERENT POINTS ALONG THE RIVERS IN PUNE CITY

M P N Results: Count per 100 ml of water Sample Collected at		Date	Count
1.	Upstream of V. wadi	22.3.83	1.4×10^6
2.	Opp. Pumping Station	25.3.83	2.0×10^5
3.	Below Garware Causeway	22.3.83	2.5×10^6
4.	Near Natraj Causeway	22.3.83	1.3×10^7
5.	Below Omkareshwar Temple	22.3.83	1.3×10^7
6.	Below Shivaji Bridge	22.3.83	3.5×10^6
7.	Below the Sangam	6.4.83	1.5×10^5
8.	In the Mula River	6.4.83	1.0×10^5
9.	In Bird Sanctuary	24.3.83	3.5×10^7

creasing concentration of organisms per 100 ml as the river flows from Vitthalwadi to Sangam Bridge. The conspicuous rise in coliform MPN indicates faecal pollution. This makes the water highly dangerous to human beings and activities such as bathing, washing clothes and utensils, which are normally carried out by citizens on the river, are fraught with danger of infection. However, as will be seen from the discussion that follows, this water, which carries a great load of organic matter, may not necessarily be dangerous to birds. Indeed it appears that certain species of birds thrive on it.

Broad Habitat-types along the River course

The 6.5 km stretch of the Mutha and the further 4 km stretch of the Mula-Mutha exhibit a variety of habitats. They are : 1) Deep water; 2) Shallow water; 3) Marshy land; 4) Grassland; 5) Rocks and boulders, and 6) Dryland and scrub. Riverside trees also constitute a distinct habitat, though arboreal birds are not considered here. Let us now see the characteristic bird-life of each of these habitats. The broad extent of each of these habitats is shown in the maps.

Deep-water Habitat

The Mutha river within Pune city is shallow with an average depth of less than a metre. In certain places, however, deepish pools are formed, e.g. near Vitthalwadi, near Omkareshwar Temple, and near the Sangam. The Mula is a bigger river and the stretch between Holkar Bridge and Sangam is deeper (average depth about 2 metres). The joint flow below Sangam is of considerable depth too, due to impoundment near Bund Garden. The river-flow is again shallow in the Bird Sanctuary.

The common submerged plants occurring in this habitat are : *Hydrilla verticillata, Lemna gibba, Ceratophyllum demersum, Vallisneria spiralis, Spirodela polyrhiza* etc. *Eichhornia crassipes* became progressively dominant after October, especially in the Mula and by March it had almost covered the open water in the Bird Sanctuary. Another obnoxious weed *Pistia stratiotes* was also recorded at a few places especially on the Mula.

The characteristic bird of this habitat appears to be Little Grebe or Dabchik. Groups of these birds were seen at every place on the Mutha where there is deepish water. The stretch of the Mula considered here does not hold any Dabchik perhaps due to lack of aquatic food and movement of boats in the river. Upstream of Garware causeway these birds were seen to breed from February onwards on little platforms made up of aquatic plants (*Hydrilla*) and floating debris. Three nests and a pair with two chicks were seen in the last week of February 1983.

Coots, Little Cormorants, a few Large Cormorants and ducks like Garganey Teals, Pintails and Shovellers were the other birds that belonged to this habitat. The Cormorants are a recent addition to the river fauna. The Little Cormorants started appearing on the river since 1969 and the Large ones came as recently as 1980. They perhaps reflect the abundance of small and medium-size fish in the river; fish that thrive on the nutrient-rich sewage water. It may be significant that the Cormorants were absent when the proportion of sewage in river-water was low, i.e. before the seventies. Do these fish-eaters indicate the quality of fish in the waterbody, in this case smaller fish? For, all the fishermen whom we asked about the quality of fish in the river, complained that good quality fish are no longer found in the river, except during a few days immediately after the monsoon. This aspect of the correlation between Cormorants and fish needs deeper investigation, however.

Ducks were concentrated in deepish pools in the Bird Sanctuary. Garganey Teals became numerous after 1972. They use the Sanctuary area during daytime for resting on rocks midstream and appear to feed on chironomus larvae and other floating insects. Over 800 were counted in early March 1983. Since 1970 an occasional Pintail used to be seen in the Sanctuary area. In the winter of 1982-83 their number was the highest recorded so far.

A few Shovellers with the colourful males outnumbering females are to be seen in the Sanctuary every winter. They feed on floating aquatic insects.

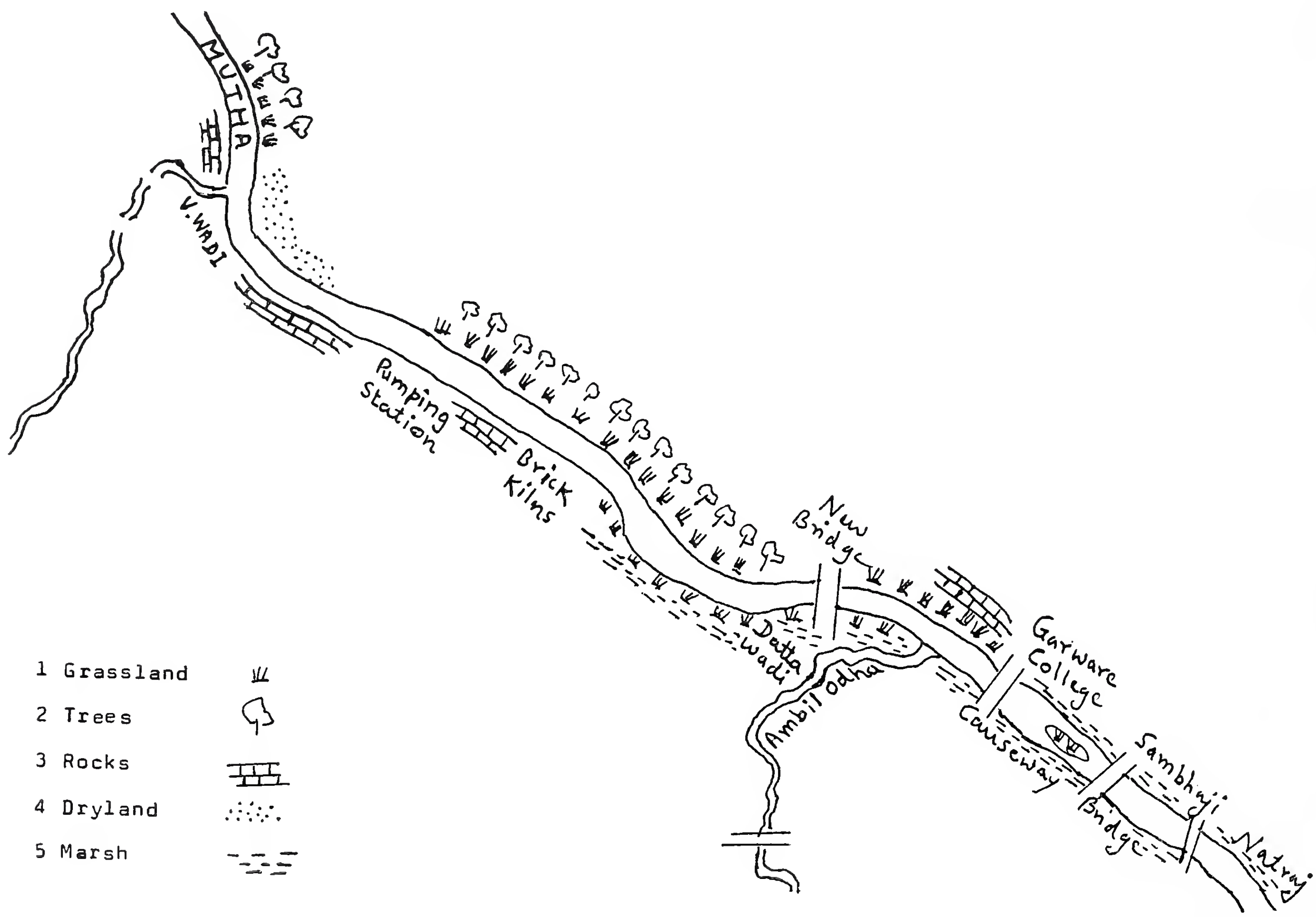
Shallow-water Habitat

Most of the stretch of the Mutha river considered here, being shallow, this habitat covers probably the greater part of the river ecosystem. The water is shallow, at places even midstream, and there are rocky outcrops, islands, floating vegetation and other debris which the birds can take advantage of, while wading through shallow water.

Plants of this habitat include partly submerged plants, plants growing at the edge of water and those growing along drains and other effluents flowing into the river. *Cryptocoryne retrospirallis, Xanthium strumarium, Ammania baccifera, Commelina* sp., *Cyperus pangorei, Polygonum glabrum, Asclepias curassavica, Hygrophila auriculata* etc. were seen to be common here.

Typha angustata, Jussiaea suffruticosa, Crinum defixum, Bacopa monnieri, Phyllanthus niruri, Ricinus communis and *Ipomoea palmata* were the common plants seen growing around sewage overflows and effluents.

The most characteristic birds of this habitat are the long-legged herons and stilts. The numbers of egrets and Black-winged stilts have risen considerably in recent years on the rivers. Intermediate and Little

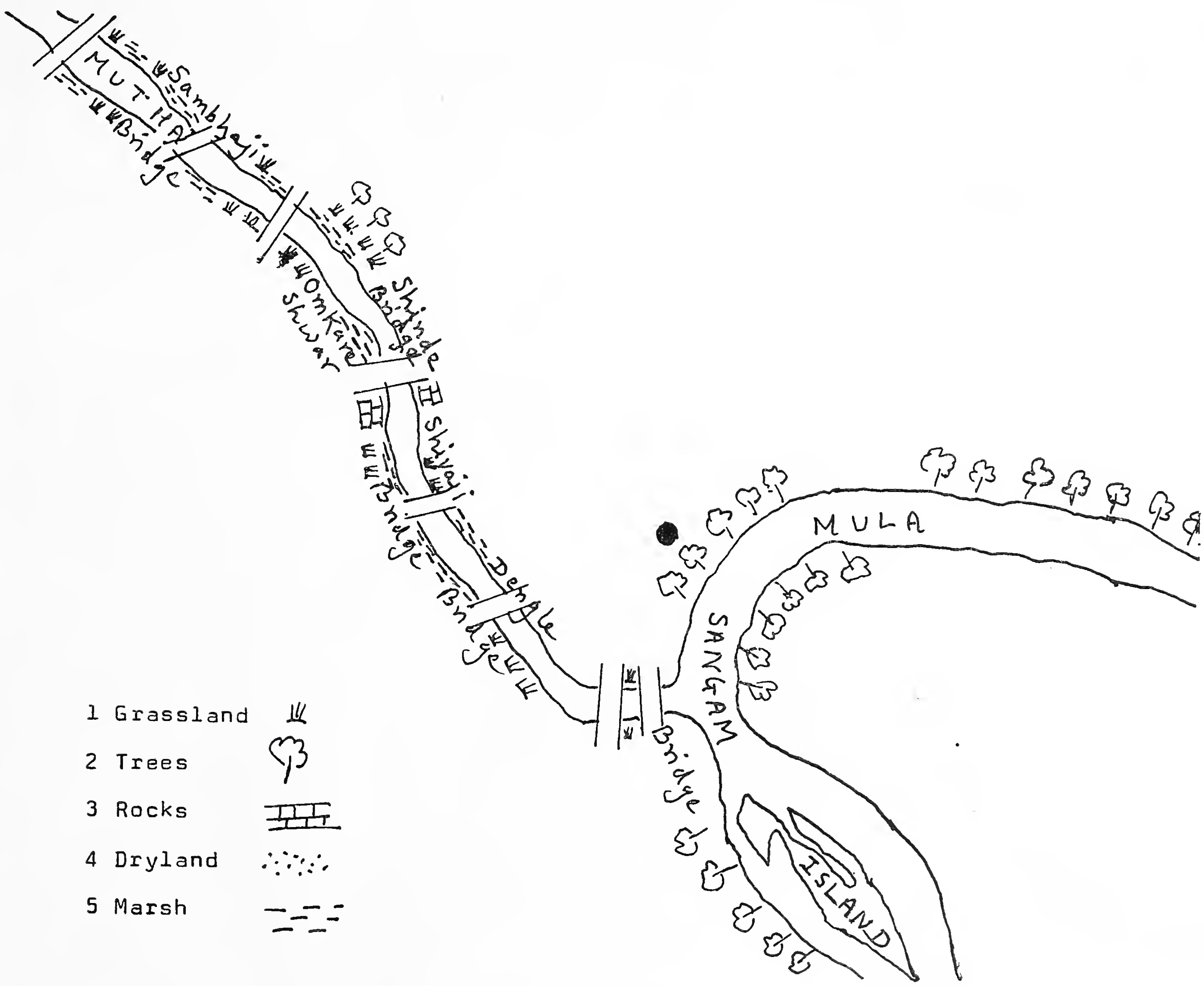


Map. 1. Habitats along the Mutha.

egrets are more common than the cattle egrets which were mostly seen around sewage overflows and accompanying cattle. The egrets perch on rocks, islands and floating debris including the weed *Eichhornia* and were also seen to congregate around streams that pour a tremendous load of faecal contamination into the rivers.

Pond herons are more solitary than egrets. They feed at the edges of water and in dense masses of *Eichhornia*. By the beginning of April some cattle and little egrets came into breeding plumage. Large egrets, Grey and Purple herons, and occasionally an open-billed stork and a White ibis were noted in this habitat, especially on the quieter stretches of the Mutha, i.e. between Dattawadi and the Pumping Station and in Bird Sanctuary. While the larger herons appeared to feed mainly on fish, egrets and pond herons were seen to catch insects from the vegetation at the edge and on islands. All the herons are only fair weather inhabitants of the rivers and disappear completely in June and July and reappear by August-end.

Blackwinged stilts are also a comparatively



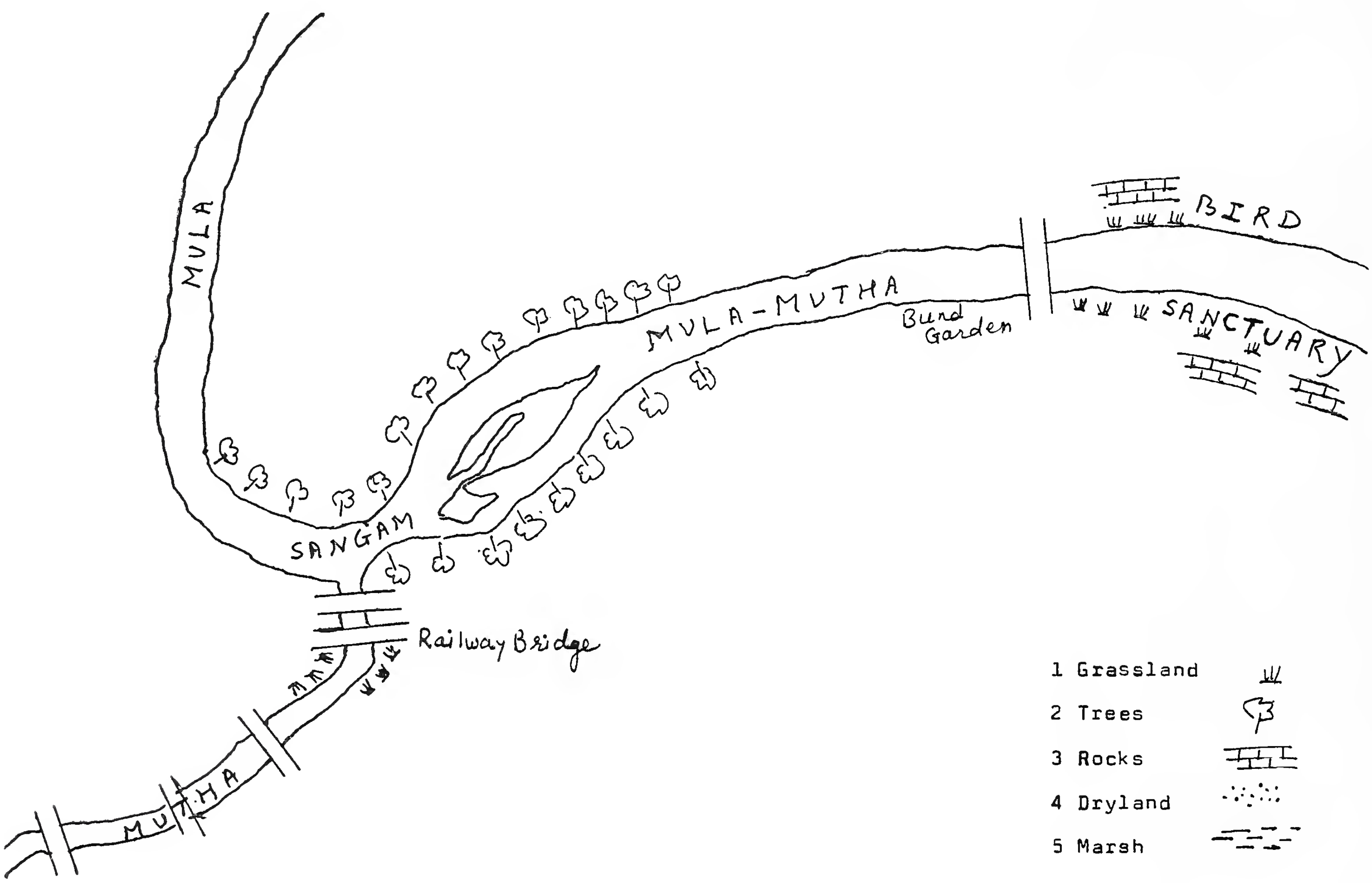
Map. 2. Habitats along the Mutha and the Mula.

recent addition to the river fauna. They were detected in some numbers in 1968-69 and since then their number has been increasing year by year. Their flocks are to be invariably met with near sewage outflows and in and around streams that pour sewage in the river. They arrive by the end of September every year and their peak numbers are reached in January. In January 1983 over 2000 could be seen on the rivers.

Three species of Sandpiper, *viz.* Common, Green and Spotted, Little stint, Greenshank, Ruff and reeve, Little Ringed Plover etc. are the other birds seen in this habitat. They are numerous where grassy edges and rock slabs touch the waters. Actually their habitat is, of late, decreasing all along the rivers as open water near the edges is being covered by *Eichhornia* especially in the Bird Sanctuary. Egrets, pond herons, wagtails and to a lesser extent sandpipers feed on mosquitoes, spiders and beetles hiding in its leaves. Yellow and White wagtails and to a lesser extent Large Pied Wagtail are thus found not only on the patches of turf and rock along the rivers but also on the floating water hyacinth.

Marshy Habitat

Water-logged areas are thinly spread along the rivers, especially where bays and inlets are formed and where there are depressions between rock slabs. Plants of this habitat are not much different from the previous one. *Ipomoea* species such as *I. carnea, I. nil, I.*



Map. 3. Habitats along the Mula-Mutha.

muricata were recorded commonly in marshy areas. Also *Marselia, Rorippa indica, Homonia riparia* were recorded from marshy places.

The characteristic bird of this habitat was seen to be Snipe (Fantail or Pintail?) and to some extent Painted Snipes were usually found hidden in the short, wet grass. Where the grass is taller and typha stands abound, hide Purple and Indian moorhens. Bronze-winged and Pheasant-tailed Jacanas used to be found on the river some years ago. The former has now completely vanished while the latter is seen in decreasing numbers year by year. Though these birds can take advantage of floating vegetation due to their long toes, they are not seen to be much associated with *Eichhornia.* Indeed there is some reason to believe that since the advent of this noxious weed, these species have declined in number.

Grassland Habitat

Wagtails usually exploit grasslands both dry and wet. Three subspecies of Yellow Wagtail are usually found along the river. In late winter the Yellowheaded wagtail adds to their numbers. There used to be enormous flocks of yellow wagtails on the dry, scrub-covered plateau and grassland on the left bank of the Mula-Mutha in the Bird Sanctuary. But as this plateau is now planted up with trees, there is a noticeable decline in the number of wagtails here. The resident Indian species of wagtail, the Large Pied, is found in pairs all along the river. They are fond of perching on rocks mid-stream and were seen to run on grass or to hunt for insects on floating *Eichhornia.*

Cyperus pangorei, C. globosus, Fimbristylis bisumbellata, Eleocharis capitata, Echinochloa colona, Cynodon dactylon, Chloris barbata are some of the typical plants of this habitat.

Rocky Habitat

Rocks are exposed in several places along the Mutha. At Vitthalwadi there is a broad platform of basalt on the right bank. There is also a broad and high rocky platform on the left of the Mula-Mutha in the Bird Sanctuary. In between there are rock exposures on both the banks of the Mutha and rocky outcrops in the shallow river-bed. The deeper Mula does not show rocky exposures on either its banks within city limits or mid-stream.

Plants growing in rock crevices and between gaps in rocks were found to be mostly grasses. *Cynodon dactylon, Cyperus pangorei, Alternanthera sessilis, Commelina* sp. were some of the plants recorded from this habitat. On wet rocks near puddles red patches of *Rotella tenuis* were observed and in rock crevices and on wet rocks *Canscora diffusa* was also seen.

Redwattled Lapwing was perhaps the most characteristic denizen of this habitat. Two species of Kingfisher, *viz.* Small Blue and Whitebreasted can be seen perched on rocks at many places. As fish and frogs are to be found in practically every part of the rivers these kingfishers are to be seen everywhere except the stretch between Sambhaji Bridge and Sangam Bridge. At Vitthalwadi and in the Bird Sanctuary there are puddles and pools formed in depressions in rocks. Redwattled Lapwing, Green Sandpiper and the two kingfishers can usually be seen on these pools. Grey Shrike, Rufousbacked Shrike and Little Brown Doves and Indian Robin are some of the other birds found here.

Dryland Habitat

Patches of dry, stony ground dotted with bushes of *Lantana, Calotropis, Pongamia* etc. can also be found along the Mutha river. On

one such plateau in the Bird Sanctuary, trees such as *Erythrina* sp., *Bauhinia* sp., *Cassia* sp., *Bombax ceiba, Cochlospermum religiosum,* etc. are now planted.

Small bushes and stunted trees provide convenient perches for a number of bird species. Rufousbacked Shrike, Common Green Bee-eater, Stonechat, Black Drongo, Large Grey Babblers are normally seen to take advantage of these. Crows and Common Mynas are attracted to these dry, dusty patches on account of the movement of men and their cattle. The Common Myna has some favourite roosting trees along the river. Before flying into these trees at dusk the Mynas use these dry slopes as gathering stops where they assemble in enormous numbers moving into the roosting trees before sunset.

Commuting birds and birds seen in flight

The broad river channel of the Mutha appears to provide a route to commuting birds. In the morning Little Cormorants, Little and Cattle and Intermediate Egrets, Common Mynas and to a lesser extent Roseringed parakeets appear to follow the river on their foraging trips. They take the reverse route in the evening. Pied Kingfishers are fond of travelling a great deal along the river course. They favour the deepish pools, perching on wires running across the river or scanning the water surface by hovering in the air. They probably require a transparent surface and consequently were seen to be common at places where the turbidity index was low. In their beats up and down the river they rarely stop to hover between Sambhaji Bridge and Sangam. Gullbilled terns and Marsh Harriers patrol the river to and fro. The terns pick up insects and floating debris from the surface while the Harrier looks for larger prey. House Swifts, Eastern Common and Redrumped Swallows and sometimes Little Pratincoles are seen to hawk insects in the air.

Trees lining the banks between Vitthalwadi and Dattawadi Bridge and again in the Bird Sanctuary area are seen to be patronised by such arboreal birds as Grey Hornbill, Golden Oriole, Koel, Crimsonbreasted Barbet, Iora, Grey Tit, Crow-Pheasant, Small Minivet etc. Even the call of the Grey Partridge could be heard from cultivation opposite the Pumping Station and near the Bird Sanctuary.

The winter of 1982-83

Between October 1982 and April 1983 systematic observation and counts of birds were carried out on the river Mutha and in the Bird Sanctuary on the Mula-Mutha. Birds were counted once every month while certain species were singled out for more intensive counts and observations. During this period 71 species of birds were recorded on the rivers. Their distribution according to habitat was:

Deep-water Habitat: 6
Shallow-water Habitat: 9
Marshland Habitat: 16
Dryland and Rocky Habitats: 24
Riverside Trees: 5
Birds in flight: 11

On any one day an average of 37 species were noted on the river Mutha during this period, with a total number of 1806 individuals. In this stretch of about 6.5 km this number gives an average density of 277 birds per kilometre. This number does not include arboreal birds seen on trees by the riverside. In the Bird Sanctuary on an average 1490 individuals belonging to 42 species were recorded on the days of counts. This 1.5 km stretch thus gives a density of 993 birds per kilometre.

As will be seen from Fig. 1 there are some

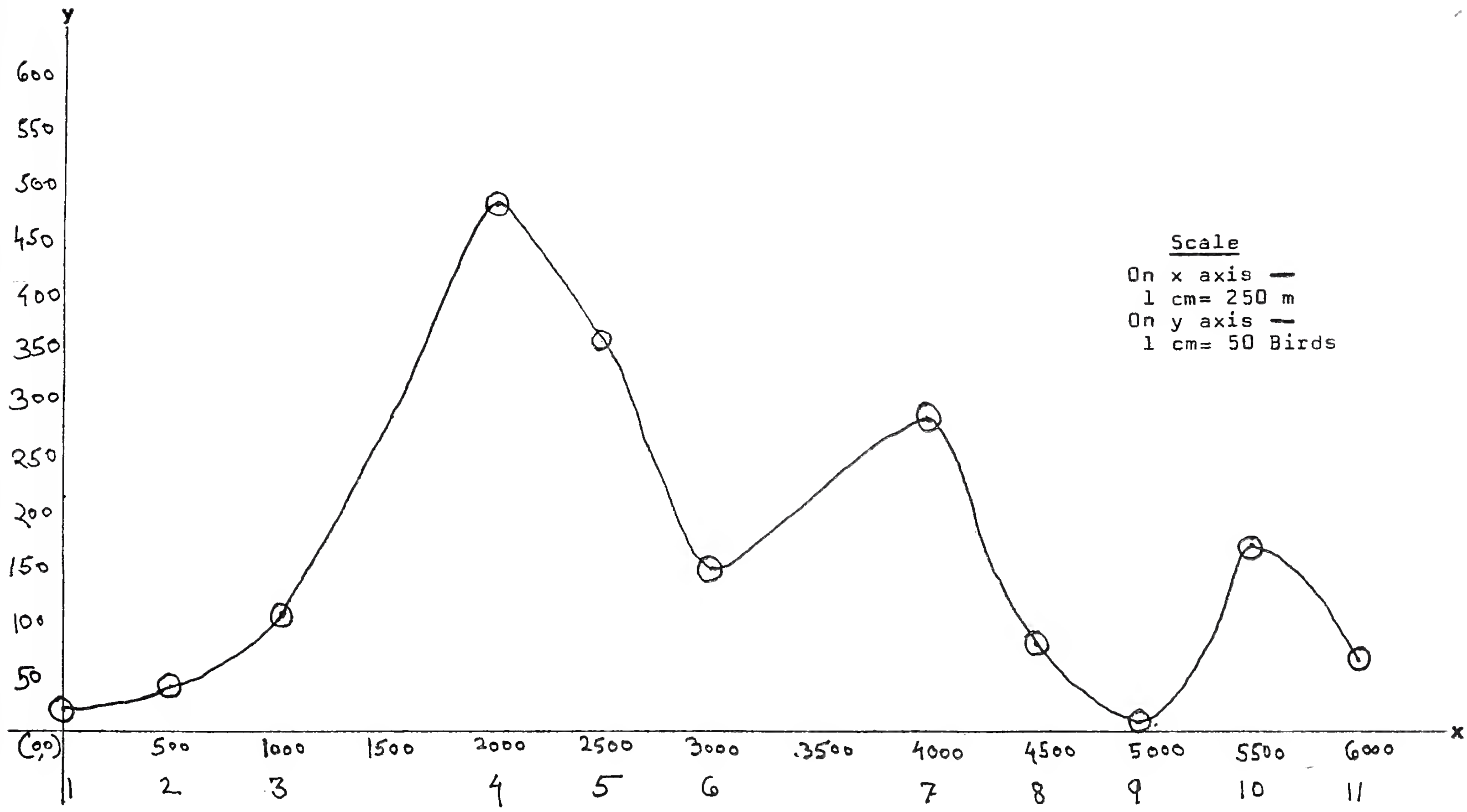


Fig. 1. Distribution of Birds along the river.

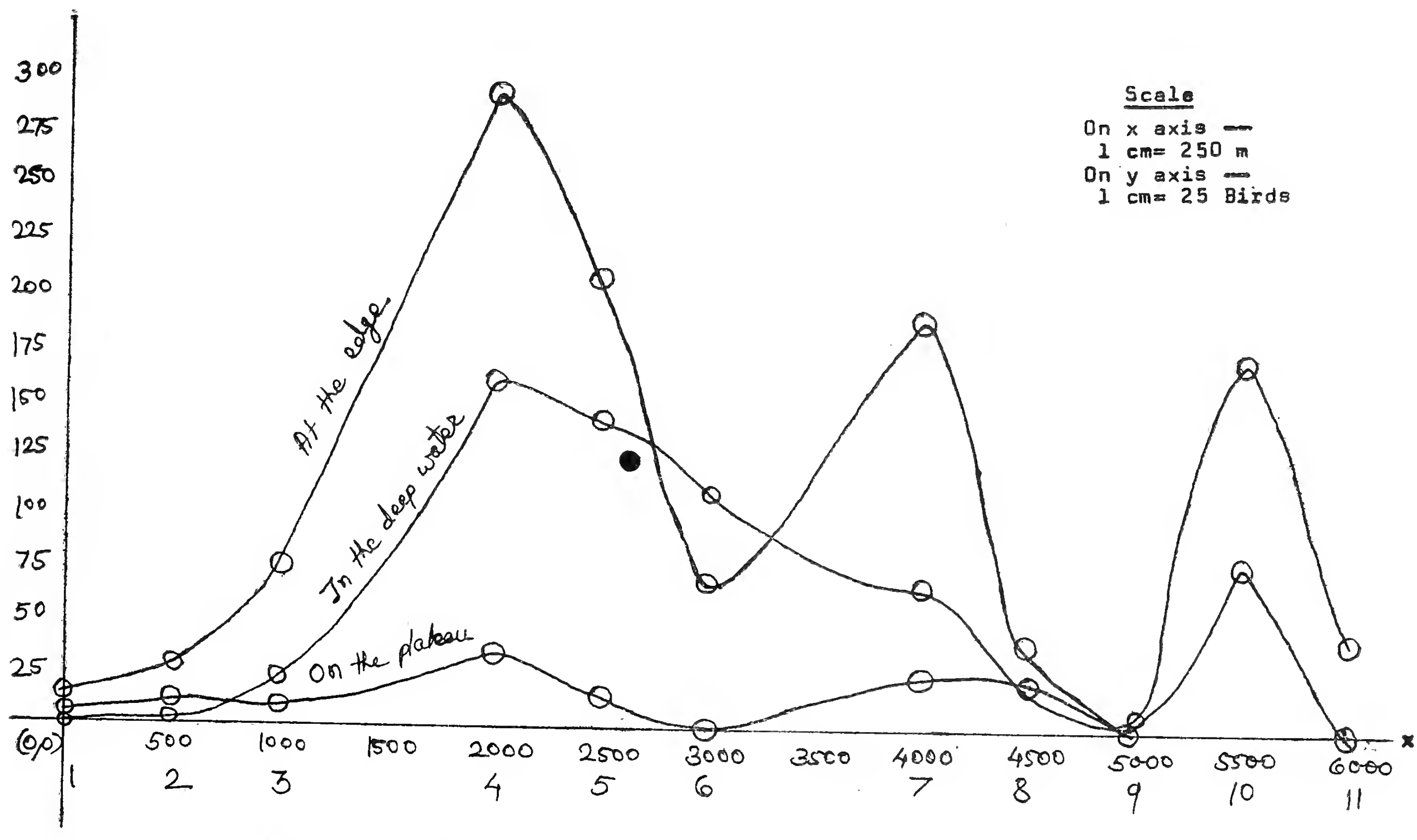


Fig. 2. Distribution of Birds along the river according to Habitat.

TABLE 2

DISTRIBUTION OF BIRDS COMMONLY SEEN ALONG THE MULA-MUTHA, JANUARY-APRIL 1983

Bird Species / THE RIVER-COURSE BETWEEN:-	(1) Vitthalwadi to Garware College Causeway				(2) Garware College Causeway to the Sangam				(3) Bird Sanctuary			
	Jan	Feb	Mar	Apr	Jan	Feb	Mar	Apr	Jan	Feb	Mar	Apr
Little Cormorant	F	F	F	F	F	F	F	F	F	F	F	F
Little Egret	F	F	C	C	C	C	VC	VC	VC	VC	A	A
Median Egret	F	C	C	VC	VC	VC	VC	VC	VC	VC	VC	VC
Cattle Egret	—	—	F	F	C	C	C	C	VC	VC	C	C
Pond Heron	F	C	C	VC	F	C	C	C	VC	VC	VC	VC
Shoveller	—	—	—	—	—	—	—	—	F	F	F	F
Dabchik	F	F	C	C	C	F	C	VC	C	A	A	A
Pintail	—	—	—	—	—	—	—	—	A	A	—	—
Garganey Teal	—	—	—	—	—	—	—	—	VC	A	A	A
Coot	—	—	—	—	—	—	—	—	F	F	F	F
Redwattled Lapwing	F	F	F	F	F	F	F	F	F	F	F	F
Blackwinged Stilt	F	C	C	C	A	A	A	A	A	A	A	C
Gullbilled Tern	F	F	F	F	F	F	F	F	C	A	VC	C
Green Bee-eater	C	C	C	C	F	F	F	F	C	C	C	C
Pied Kingfisher	F	F	F	F	F	F	F	F	F	F	F	F
Small Blue Kingfisher	F	F	F	F	F	F	F	F	F	F	F	F
White-breasted Kingfisher	F	F	F	F	F	F	F	F	F	F	F	F
Yellow Wagtail	C	C	C	C	F	F	F	F	VC	VC	VC	VC

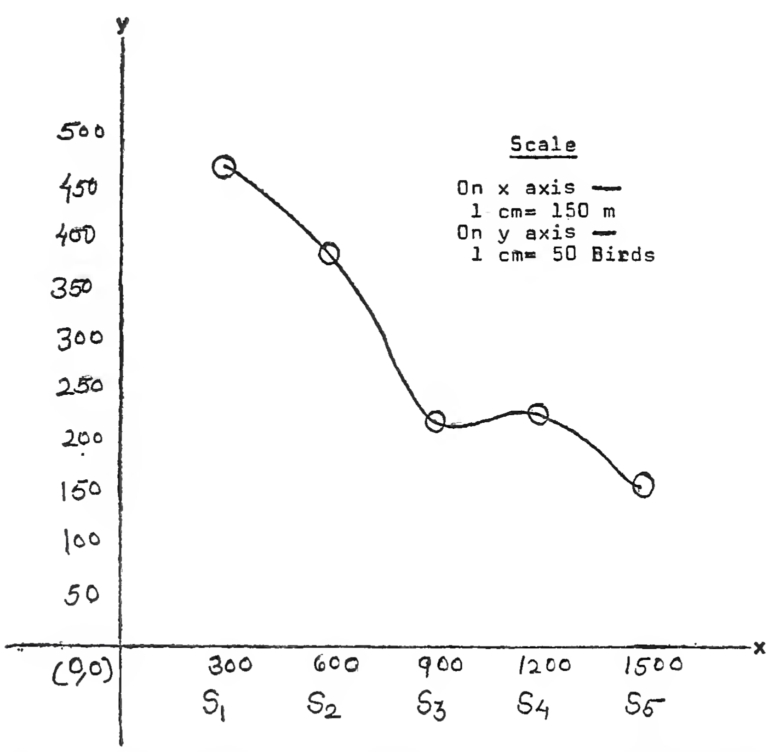


Fig. 3. Distribution of Birds in the Bird Sanctuary.

definite places where birds were seen to congregate. These three places according to the number of birds found there, are: 1. The stretch between the Pumping Station and Dattawadi Bridge, 2. The stretch between this bridge and Garware College causeway, 3. The stretch between the broken causeway behind PMT bus terminus and Omkareshwar temple. Fig. 3 shows the distribution of birds in the Bird Sanctuary.

Fig. 2 shows birds at different places along the river Mutha according to three broad habitat types. As will be seen from the figure, the number of birds seen along the edges of the river was the highest followed by the number seen in deepish water. The number of species seen along the edges was 15 while those

TABLE 3

DISTRIBUTION OF MORE NUMEROUS BIRDS ALONG THE MULA-MUTHA, JANUARY 1983.

River-course between:- (1)

	Vitthalwadi				Pumping Station				Dattawadi Br.				Garware Causeway			
	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap
Egrets	C	F	F	F	F	C	C	VC	C	C	VC	VC	C	C	VC	VC
Pond Herons	F	F	F	F	F	C	C	VC	F	C	C	C	F	C	C	C
Dabchik	F	F	—	—	F	F	C	C	C	VC	VC	C	C	F	C	VC
Blackwinged Stilt	F	F	F	F	F	C	C	C	A	A	A	VC	A	A	A	A
Gull-billed Tern	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

River-course around:- (2)

	Sambhaji Br.				Omkareshwar				Shivaji Br.			
	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap
Egrets	VC	C	VC	C	C	C	C	C	F	F	F	F
Pond Herons	C	C	C	C	C	C	C	C	F	F	F	F
Dabchik	F	F	—	—	C	C	C	C	F	F	F	F
Blackwinged Stilt	VC	A	VC	C	C	A	C	C	F	F	—	—
Gull-billed Tern	F	—	—	—	F	F	—	—	F	F	F	—

River-course around:- (3)

	Dengle Br.				Sangam Br.				Bird Sanctuary			
	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap	Ja	Fe	Ma	Ap
Bird-Species	C	C	C	C	C	VC	VC	C	A	A	A	A
Pond Herons	C	C	C	C	C	C	C	C	VC	VC	VC	VC
Dabchik	C	C	VC	C	VC	VC	C	C	A	A	A	C
Blackwinged Stilt	F	F	F	F	F	F	F	F	C	A	A	A
Gull-billed Tern	C	C	F	F	C	C	F	F	C	A	VC	C

Explanation: Table Nos. 2 and 3.

F Bird no.s between 1 and 10, i.e. Few
C Bird no.s between 11 and 30 i.e. Common
VC Bird no.s between 31 and 70 i.e. Very Common
A Bird no.s between 71 and above i.e. Abundant
Ja January
Fe February
Ma March
Ap April

seen in deepish water was 7. Some of the species like Blackwinged Stilt were common to both these habitats. In the Bird Sanctuary (Fig. 4) the number of species seen along the

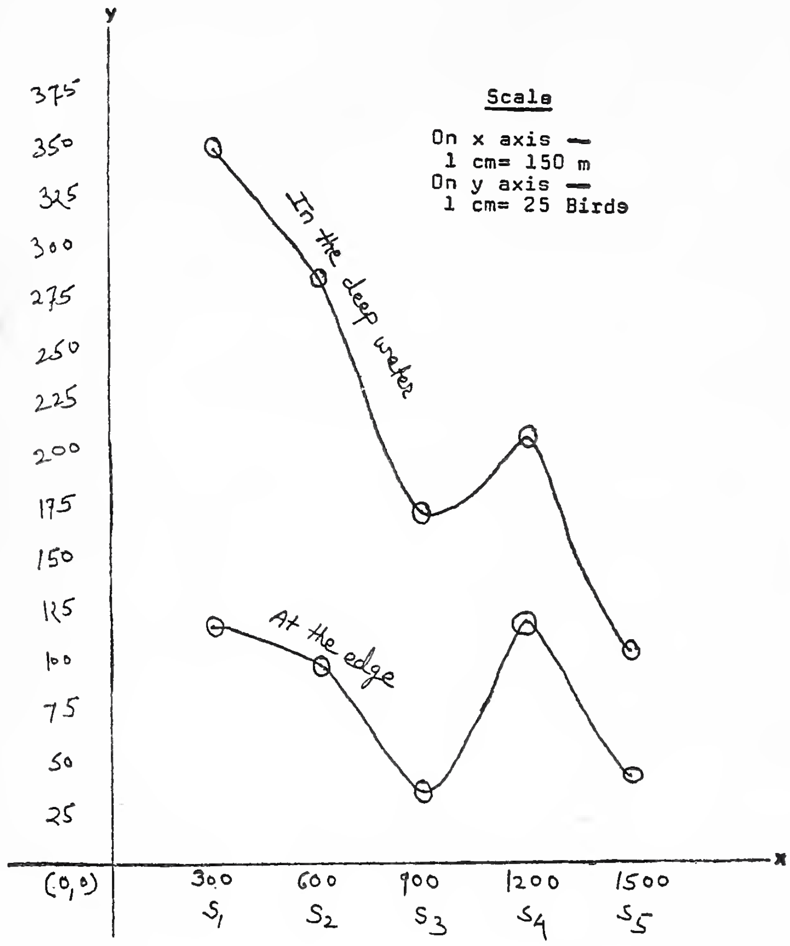


Fig. 4. Distribution of Birds in the Bird Sanctuary according to Habitat.

edges was 17 while in deepish water the number was 12. While counting these numbers such species as House and Jungle Crow, Common Myna, Pariah Kite and Little Brown Dove which are not strictly river-birds are excluded. In the bird count taken in March 1979, in the Bird Sanctuary, 39 species had been recorded with a total number of about 1200 individuals (P. Gole 1980).

The quality of water where birds were seen to concentrate, was also examined. As has been pointed out in the section on water-quality, the river takes on an increasing load of organic pollution as it flows from Vitthalwadi onwards. It will now be interesting to see if any change in the composition of bird species in different months on the stretches where birds concentrated, can be detected. Table No. 2 gives this information. The table shows that in the first two stretches the numbers of egrets, stilts, dabchiks, and Gullbilled terns are low; while these birds become more numerous from Garware College causeway to Omkareshwar temple. We have recorded in greater detail the distribution of these species between January and April. Table No. 3 shows their distribution along the entire river course. From this it is clear that these birds are fewer where the quality of water is better and drains do not overflow into the river. Their numbers progressively increase as the quality of water deteriorates and its organic content goes up. It appears that these birds have adopted the role of scavengers along the river course. Special mention should be made of Blackwinged Stilt. These were found to be concentrated, at places in very large numbers, where streams loaded with faecal matter and drains flow into the river. To a lesser extent this can be said to be true of the three species of egrets also. Gullbilled terns were also seen to patronize such places in numbers and to swoop repeatedly to pick up floating organisms.

As the summer advances and April gives way to May, most of the migratory birds including the hordes of Blackwinged Stilt which make the dirty river so colourful, will have left. June and July would see even the egrets disappearing from the river. With the monsoon in full swing, floods roar down the river channel and the turbulent stream appears to cleanse itself of all the dirt that man continues to heap on it.

Acknowledgements

The study formed a part of the much wider

investigation aimed at drafting an eco-development plan for the improvement of Pune's river-fronts. This wider study was financed by the Ecological Society of Pune. I was helped in the field by Miss S. Limaye, Miss S. Ranjekar and Miss S. Jangam. The water-samples were analysed by Shri Kirad of Kirloskar Consultants Ltd. and Dr. Godbole of Vidnyan-vardhini. Botanical specimens were identified by Dr Vartak of Vidnyan-vardhini and Miss Sane of Garware College. I thank all these persons.

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ORCHIDS OF GREAT NICOBAR ISLAND AND THEIR CONSERVATION[1]

D. K. Hore[2] and N. P. Balakrishnan[3]

The paper lists 33 taxa of orchids recorded so far from the Great Nicobar island, emphasising the field observations, habitat and ornamental potentialities. Phytogeographical affinities of the species has been drawn up. Strategies and measures on conservation of orchid species in the island has also been proposed. Several species are illustrated with photographs.

Introduction

The Great Nicobar Island is a continental island belonging to the Andaman and Nicobar group of islands. It occupies a phytogeographically strategic position in the SE Asian tropics, situated between mainland India, on the one hand and Sumatra and Malay peninsula on the other. The island has an area of 1045 sq. km. and lies between 6°45′N and 7°15′N latitudes and 93°37′E and 93°56′E longitudes. This southernmost Indian land area is hardly 145 km away from Sumatra.

The topography of the island is highly rugged. It has long narrow stretches of flat land scattered along coasts and hilly ranges running in north-south and east-west directions. The different hill ranges culminate in the peak called Mount Thullier which is 670 m high above m.s.l. The island is basically mountainous with several rivers and perennial streams. At some places the coastal areas are fringed with coral reefs extending almost from the shoreline to some considerable distance out to the sea. There are no deep lagoons between the reef and shore. Dense forests occupy about 85% of the whole island, starting from the coastal forest zone to right up to the peaks.

The climate of the island is purely tropical. The daily temperature ranges from 22°—32°C with mean relative humidity of about 82%. The annual rainfall ranges from 300 to 380 cm. April is the hottest month of the year. The island is subjected to gales and cyclonic winds changing in direction with the monsoons and due to sudden depressions in the sea around.

The forests of Great Nicobar Island are mainly evergreen with a few deciduous elements. They consist of mostly tall trees, palms, climbers, epiphytes and ferns. The dense vegetation supports much diversity in its species content. The vegetation can be classified into six major types : 1) Beach formations, 2) Saline swamps, 3) Lowland littoral swamp forests (mixed with a few deciduous elements), 4) Riverain vegetation, 5) Inland forests of hills and low mountains (mixed with a few deciduous elements), and 6) Secondary vegetation. There is hardly any aquatic vegetation on the island due to lack of freshwater ponds and lakes. Pure grasslands are not found, although a few weeds come up very fast as secondary formations due to the deforestation in certain areas of the island.

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These continental islands of the Andaman and Nicobar islands, which lie in the tropical zone are very little explored, due to their isolation and inaccessibility. But several expeditions were undertaken to this island by botanists like Kurz (1876), Sahni (1953), Thothathri (1973) and Balakrishnan (1976-78). Between 1979 and 1981, six field trips were undertaken, each lasting more than a month, in order to intensively study the floral constituents of the island. All these field trips provided rich collections and the orchids are enumerated here in the following inventory.

All together 33 taxa of orchids belonging to 26 genera have been recorded so far from this island. The number of species is the highest among the monocotyledonous families so far known from this island. Some of these species were studied earlier and categorised as rare, endemic and endangered by Balakrishnan (1977, 1978).

In the enumeration of the species below, emphasis is given on the habit, field observations on flowers, frequency of distribution, habitats along with suggestions for introduction into gardens, and full citation of specimens with localities and the herbaria in which they are housed.

Enumeration

1. **Aerides emericii** Reichb. f. in Gard. Chron. 18(2) : 586. 1882; Hook. f., Fl. Brit. India 6 : 47. 1890.

Epiphyte, inflorescence slender, *c.* 20-30 cm long; flowers pinkish. Frequent in coastal as well as inland forests. Suitable for cultivation in gardens.

Flowers. April-May.

Fruits. June-July.

Specimens. 36 km on East-West road, *Balakrishnan* 3956 (PBL); Campbell Bay, *Balakrishnan* 5514 (PBL); Campbell Bay, *Hore* 7281 (PBL, CAL); Kopenheat, *Hore* 8216 (PBL).

Distribution. Endemic to Nicobar Islands.

2. **Anoectochilus nicobaricus** Balakr. & P. Chakrab. in Bull. Bot. Surv. India 20 : 80. 1978.

Terrestrial, erect herb, *c.* 15-30 cm; leaves 3-4, dark purplish with golden reddish reticulate venation above, dark brownish below; inflorescence 4-8 flowered, solitary, terminal; sepals greenish purple; lip white. In shaded places on the inlands mixed forest floor. Rare and hence necessary to propagate them in Botanic Gardens. Commonly known as 'Jewel orchid', this ornamental orchid can be cultivated in gardens.

Flowers. November-December.

Fruits. Unknown.

Specimens. 6 km on East-West road, *P. Chakraborty* 3226 (PBL); Galathea river bank, *N. G. Nair* 7147 (PBL).

Distribution. Endemic to Great Nicobar Island.

3. **Appendicula reflexa** Bl. Bijdr. 301. 1825.

Epiphyte, inflorescence mostly axillary; peduncles short; flowers greenish white, *c.* 15 cm long, few-flowered. Rare in forests of marshy coastal areas as well as shaded inland forests.

Flowers. June-July.

Fruits. July onwards.

Specimens. 20 km on North-South Road, *Balakrishnan* 3834 (PBL, CAL); Campbell Bay to Chengappa Bay, *Balakrishnan* 6082 (PBL); Galathea river mouth, *N. G. Nair* 7125 (PBL).

Distribution. Great Nicobar Island, Thailand, Sumatra to New Guinea.

4. **Ceratostylis subulata** Bl. Bijdr. 206. 1825.

Epiphyte, stem clustered, 15-20 cm; flowers creamy-white or yellow, minute. Scarce in shaded inland forests.

Flowers. August-December.

Fruits. Unknown.

Specimens. Campbell Bay, *Thothathri & Banerjee* 11419 (CAL); 17 km on East-West Road, *Balakrishnan* 3033 (PBL, CAL, L); Near Galathea Bridge on East-West Road, *N. G. Nair* 7185 (PBL, CAL); Laful forest, *Hore* 8785 (PBL).

Distribution. Great Nicobar Island, Burma, Malaya and Java.

5. **Cleisostoma uraiense** (Hayata) Garay & Sweet in Orch. S. Ryukyu Isl. 156. 1974. *Sarcanthus uraiensis* Hayata, Ic. Pl. Formos. 8 : 130, f. 58. 1919.

Epiphyte; flowers on 15-20 cm long panicles, on upper leaf axils; flowers greenish white; lip white; fruits black when dry. Sparsely distributed in coastal, littoral as well as inland forests.

Flowers. July-August.

Fruits. September-October.

Specimens. Campbell Bay, *Thothathri & Banerjee* 11346 (CAL, PBL); Campbell Bay, *Balakrishnan* 2937 (PBL, CAL, L); Galathea river to Pygmalion Point, *Balakrishnan* 3869 (PBL); Chengappa Bay, *Hore* 7721 (PBL); 4 km on North-South Road, *Hore* 8287 (PBL).

Distribution. Philippines, Taiwan and Formosa. Probably introduced and naturalized in Great Nicobar Island.

6. **Corymborkis veratrifolia** (Reinw.) Bl. in Coll. orch. Arch. Ind. 125 : tt. 42 E & 43. 1859. *Hysteria veratrifolia* Reinw. in Bot. Zeit. 2 : 5. 1825.

Terrestrial, *c.* 1 m or more, erect or a little slender; flowers white in axillary panicle; fruits greenish. Common in certain localities in shaded inland and coastal littoral forests. Valued as febrifuge in treating Malaria.

Flowers. June-July.

Fruits. August-September.

Specimens. Casuarina Bay and Pulokunio, *Thothathri & Banerjee* 11559 (CAL); 20 km North-South Road, *Balakrishnan* 3829 (PBL, CAL, L); 25 km East-West Road, near Galathea river, *Balakrishnan* 5797 (PBL); Pulo Kunyi, *Hore* 8260 (PBL); Pygmalion Point, littoral forest, *Hore* 8835 (PBL).

Distribution. Peninsular India, NE India, Burma, Malaysia, Singapore, Java and Sri Lanka.

7. **Cymbidium pubescens** Lindl. in Edw. Bot. Reg. 26 : Misc. 75, 27, t. 38. 1841; Hook. f. Fl. Brit. India 6 : 11. 1890.

Epiphyte; inflorescence racemose, *c.* 15 cm; stalk arising from rootstock, few flowered; flowers brownish red; perianth with yellow margins; lip with yellow spot at middle on disc. An ornamental orchid, suitable for cultivation; rare in shaded places in inland forests.

Flowers. August-September.

Fruits. Unknown.

Specimens. Campbell Bay, *Balakrishnan* 2799 (PBL, CAL).

Distribution. Great Nicobar Island, Burma, Thailand, Malaya, Singapore and Indonesia.

8. **Dendrobium anceps** Sw. in Vet. Act. Holm. 246. 1800.

Epiphytic slender herb; flowers from leaf axils, solitary or paired, white or creamy yellow; lip yellowish inside. Common in inland mixed or evergreen forests.

Flowers. June-December.

Fruits. Not known.

Specimens. Campbell Bay, *Balakrishnan* 2948 (PBL, CAL); 30 km on East-West Road, *Balakrishnan* 4012 (PBL, CAL); Campbell Bay to Chengappa Bay, *Balakrishnan* 5696 (PBL, CAL); 26 km on East-West Road, *N. G. Nair* 7189 (PBL, CAL); Chingenh, *Hore* 8850 (PBL).

Distribution. NE. India, Burma, Thailand and Indo-China.

9. **Dendrobium crumenatum** Sw. in Schrad. J. Bot, 2 : 237. 1799.

Epiphyte, often leafless when in flowers, pseudobulb 20-45 cm; flowers from naked nodes, solitary, white, sweet-scented. Scattered along coastal and inland forests in shaded places. An ornamental herb, popularly known as 'Pigeon Orchid', can be cultivated in gardens.

Flowers. April-August.

Fruits. Unknown.

Specimens. Campbell Bay, *Balakrishnan* 2933 (PBL); Kopenheat to Koshindon, *Balakrishnan* 4028 (PBL, CAL); 14-15 km on North-South Road, *Balakrishnan* 5845 (PBL); Galathea Bay, *Thothathri* & *Banerjee* 11480 (CAL); Campbell Bay, *Hore* 8820 (PBL).

Distribution. Sri Lanka, India, Burma, Indo-China, Taiwan, Malaya, Java and the Philippines.

10. **Dendrobium pensile** Ridl. in J. Linn. Soc. 32 : 253. 1896 *et* Fl. Mal. Pen. 4 : 40. 1924.

Epiphytic, drooping herb; leaves alternate; flowers axillary, small, white. Scarce in lowland forests near coastal areas.

Flowers. June-July.

Fruits. August-September.

Specimens. 15 km on North-South Road, *Balakrishnan* 6081 (PBL); 41 km on East-West Road, *Hore* 8235 (PBL).

Distribution. Nicobar Islands, Malaya and Singapore.

11. **Eria bractescens** Lindl. in Edw. Bot. Reg. 27. 1841, et Misc. 18: 30, t. 29. 1844.

Epiphyte; inflorescence in spikes, *c.* 10-13 cm long, showy; flowers white; lip with reddish lamellae on disc; column with red patches. Scattered in beach and inland forests. Ideal orchid for gardens as they can be easily cultivated.

Flowers. May-June.

Fruits. July-August.

Specimens. Galathea Bay, *Thothathri* and *Banerjee* 11466 (CAL); Great Nicobar Island, *Balakrishnan* 5627 (PBL, CAL).

Distribution. NE India, Andaman & Nicobar islands, Burma, Malaya, Singapore, Java and the Philippines.

12. **Eria bractescens** Lindl. var. **kurzii** Hook. f. Fl. Brit. India 5: 797. 1890.

Epiphyte; flowers white with pinkish brown lip. Mostly seen in beach forests associated with ferns; can be introduced into gardens.

Flowers. March-May.

Fruits. Unknown.

Specimens. Campbell Bay, *Thothathri* & *Banerjee* 11312 (CAL).

Distribution. Endemic to Andaman & Nicobar islands.

13. **Flickingeria fimbriata** (Bl.) Hawkes in Orch. Weekly 2, 46 : 454. 1961. *Desmotricum fimbriatum* Bl. Bijdr. 329. 1825.

Epiphyte; flowers solitary from leaf axils; petals and sepals creamy white or white; lip fringed with purple or brown-red spots on upcurved lateral lobes. Scarce along mixed lowland forests. Prolonged flowering plant suitable for introduction into gardens.

Flowers. June-December.

Fruits. Unknown.

Specimens. Pulo babi, *Sahni* 23018 (DD); Near Kopenheat, *Balakrishnan* 3904 (PBL, CAL); 25 km on East-West Road, *Balakrishnan* 5789 (PBL); 31 km on East-West Road, *Hore* 8232 (PBL).

Distribution. India, Sri Lanka, Malaya, Java and the Philippines.

14. **Goodyera procera** (Ker-Gawl.) Hook. f. in Exot. Fl. 1 : 3, t. 39. 1823 et Fl. Brit. India 6 : 111. 1890. *Neottia procera* Ker-Gawl. in Bot. Reg. 8 : t. 639. 1822.

Terrestrial, erect herb, *c.* 0.2-0.3 m, inflorescence a terminal spike; flowers greenish-white, fragrant. Popularly known as 'Rattle snake'

Orchid. Seen along rocky, shaded, stream-sides in humid places; very rare in the island.

Flowers. May-June.

Fruits. July-August.

Specimens. Navy Dera, *Hore* 7592 (PBL).

Distribution. India, Sri Lanka, Burma, Indo-China, Malaya, Java, the Philippines, Taiwan and Japan.

15. **Hetaeria obliqua** Bl. in coll. Orch. Arch. Ind. 104, t. 34, f. 1. 1858.

Terrestrial orchid, *c.* 1 m high; flowers in terminal spikes; petals creamy; column yellow. Rare in inland forests on shaded humus covered forest floors.

Flowers. March-April.

Fruits. Unknown.

Specimens. Campbell Bay, *Thothathri & Banerjee* 11416 (CAL); Casuarina Bay, *Thothathri & Banerjee* 11566 (CAL).

Distribution. Nicobar Islands, Malaya and Indonesia.

16. **Hetaeria oblongifolia** (Bl.) Bl. in Coll. Orch. Arch. Ind. 102, t. 32. 1858. *Etaeria oblongifolia* Bl. Bijdr. 410, f. 14. 1825.

Terrestrial herb, *c.* 0.5 m erect; flowers in terminal spike, whitish yellow; dried fruits brown. Rare in low hilly moist forest floor.

Flowers. March-April.

Fruits. May onwards.

Specimen: Laful forest, *Hore* 7782 (PBL).

Distribution: Nicobar Islands, Bangladesh, Burma, Thailand, Malaya, Java, the Philippines, New Guinea and Australia.

17. **Luisia teretifolia** Guad. in Freyc. Voy. Uranie et Physic. Bot. 427, t. 37. 1829.

Crowded epiphyte without pseudobulb, rigid, terete; leaves terete; flowers small, few in axillary spikes, short peduncled, purplish green; fruits pale greenish yellow. Scarce along low inland forests.

Flowers. May-June.

Fruits. July.

Specimens. Kopenheat to Koshindon, *Balakrishnan* 4031 (PBL, CAL); 4 km on East-West road, *R. P. Dwivedi* 8507 (PBL).

Distribution. Sri Lanka, Peninsular India, NE. India, China, Burma, Malaysia, Indonesia, the Philippines and New Caledonia.

18. **Nervilia punctata** (Bl.) Makino in Bot. Mag. Tokyo 16 : 199. 1902. *Pogonia punctata* Bl. Mus. Bot. Lugd.-Bat. 1 : 32, 1849.

Terrestrial, rhizomatous herb, *c.* 11 cm; leaf solitary, simple, palmate, slightly reddish, purple beneath; flowers pale yellowish green with a few scattered purplish spots inside. Scarce in inland hill forests, prefers shade and grows well on humus covered soil. A plant suitable for pot culture. Used as medicine in Asiatic tropics.

Flowers. April-May.

Fruits. Unknown.

Specimens. Campbell Bay to Chengappa Bay, *Balakrishnan* 5709 (PBL, CAL); Near Shompen hut, 36.8 km on East-West Road, *Balakrishnan* 5817 (PBL, CAL).

Distribution. Great Nicobar Island, Thailand, Malaysia and Indonesia.

19. **Phalaenopsis speciosa** Reichb. f. in Gard. Chron. n.s. 15 : 562 1881; Hook. f. Fl. Brit. India 6: 30. 1890.

Epiphyte with long aerial roots, inflorescence stalk *c.* 15-30 cm; peduncle 2.5-3 cm long; flowers spreading, *c.* 3-3.5 × 4-4.5 cm; lip with deep purple or reddish tinge. Scarce in deep interior of inland forest. Flowers longlasting and useful in cut-flower trade. Conservation in botanic gardens is necessary as the wild population is restricted and endangered and threatened with extinction.

Flowers. May-August.

Fruits. Unknown.

Specimens. Laful forest, *Hore* 7767 (PBL).

Distribution. Endemic to Andaman & Nicobar islands.

20. **Phalaenopsis speciosa** Reichb. f. var. **tetraspis** (Reichb. f.) Sweet in Amer. Orch. Soc. Bull. 37: 1092. 1968. *Phalaenopsis tetraspis* Reichb. f., Xenia Orchid. 2: 146. 1868; Hook. f. Fl. Brit. India 6: 30. 1890.

Epiphyte; inflorescence stalk *c.* 12-40 cm, long; flowers in spikes, white reddish transverse patches inside; lip yellowish, hairy. Rare and rather uncommon in dense inland forests. Flowers longlasting, hence suitable for cultivation in gardens.

Flowers. May-November.

Fruits. Not known.

Specimens. 17 km towards East-West Road, *P. Chakraborty* 3212 (PBL, CAL, AMES); Navy Dera, *Hore* 7289 (PBL).

Distribution. Andaman & Nicobar islands and Java.

21. **Pholidota pallida** Lindl. in Bot. Reg. sub. t. 1777. 1836.

Epiphyte, pseudobulb oblong; inflorescence in spike, longer than leaf length; flowers white. Rare in beach and littoral forests.

Flowers. August-October.

Fruits. November-December.

Specimens. Way to Chengappa Bay, *Thothathri & Banerjee* 11437 (CAL); Campbell Bay, *Balakrishnan* 3028 (PBL, CAL, L); Baludera, *Hore* 6763 (PBL, CAL); Dogmar river bank, *Hore* 7972 (PBL).

Distribution. Andaman and Nicobar island, Burma, Indo-China, Malaya, Java, the Philippines and Australia.

22. **Plocoglottis javanica** Bl. Bijdr. t. 21. 1825; Hook. f. Fl. Brit. India 6: 22. 1890.

Terrestrial, slender or erect herb, *c.* 60 cm; leaves arising from rootstock; petioles *c.* 20 cm long; inflorescence longer than leaves; peduncle reddish green; flowers pale yellow or white with purple or red spots inside. Sparsely distributed in shaded humus covered forest floor in dense inland forests.

Flowers. July-November.

Fruits. Unknown.

Specimens. 35 km on East-West Road, *Balakrishnan* 3989 (PBL, CAL); Laful to Navy Dera, *Hore* 7743 (PBL).

Distribution. Great Nicobar Island, Burma, Thailand, Malaya, Sumatra and Java.

23. **Podochilus microphyllus** Lindl. Gen. Sp. Orch. 234. 1835; Hook. f. Fl. Brit. India 6: 81. 1890.

Epiphyte; flowers solitary, terminal, white with a combination of purple lines on each sepal and purple patches at the centre of petals. Few or scattered in shaded inland forests and edges of forests.

Flowers. December.

Fruits. July.

Specimens. 35 km on East-West Road, *Balakrishnan* 3892 (PBL, CAL); 30 km on East-West Road, *N. G. Nair* 7204 (PBL).

Distribution. Great Nicobar Island, Burma, Thailand, Malaya, Sumatra and Java.

24. **Pomatocalpa andamanicum** (Hook. f.) J. J. Smith in Nat. Tijdschr. Ned. Ind. 72: 103. 1912. *Cleisostoma andamanicum* Hook. f. Fl. Brit. India 6: 71. 1890.

Epiphyte; flowers white; fruits green. Rare in Great Nicobar Island, found in beach forests.

Flowers March-May.

Fruits. April onwards.

Specimens. Campbell Bay, *Thothathri & Banerjee* 11313 (CAL); Campbell Bay, *Balakrishnan* 2937 (PBL, CAL, L).

Distribution. Endemic to Andaman & Nicobar Islands.

25. **Pomatocalpa wendlandorum** (Reichb. f.) J. J. Smith in Nat. Tijdschr. Ned. Ind. 72: 108. 1912. *Cleisostoma wendlandorum* Reichb.

f. in Otto & Dietr. Allgemein. Gartenz. 24: 219. 1856; Hook. f. Fl. Brit. India 6: 74. 1890.

Epiphyte; inflorescence 5-10 cm, arising from root axils; flowers in racemes, creamy yellow with pinkish-brown striations; fruits green. Frequent in beach forests. Can be cultivated in gardens.

Flowers. March-April.

Fruits. May onwards.

Specimens. Way to Chengappa Bay from Campbell Bay, *Thothathri & Banerjee* 11436 (CAL); Laful, *Hore* 7590 (PBL, CAL).

Distribution. Andaman and Nicobar islands, Assam and Burma.

26. **Pteroceras berkeleyii** (Reichb. f.) Holtt. in Kew Bull. 14 (2): 269. 1960; *Thrixspermum berkeleyii* Reichb. f. in Gard. Chron. ser. 2, 17: 557. 1882.

Epiphyte; inflorescence axillary racemes, 17-20 cm long, somewhat pendulous; peduncles 2-2.5 cm; flowers white, delicate; fruits *c.* 14 cm long, needle-like. Rare in dense inland humid forests. This orchid with attractive flowers is suitable for cultivation in gardens.

Flowers & Fruits. May-June.

Specimens. Laful, *Hore* 8722 (PBL).

Distribution. Andaman and Nicobar islands and Malaya.

27. **Spathoglottis plicata** Bl. Bijdr. 401, t. 76. 1825.

Terrestrial, erect herb, *c.* 60-100 cm high; inflorescence stalk directly arising from the rootstock and about double the length of the leaves; flowers pink, velvety purple or reddish, crowded at apex, fruits oblong. Open sunny hillslopes, at 25-200 m altitude; frequently seen in large populations. Very easily cultivable and suitable for gardens.

Flowers & Fruits. June-November.

Specimens. 12 km on East-West Road, *P. Chakraborty* 3214 (PBL); 36 km East-West Road, *Balakrishnan* 3957 (PBL); 33 km East-West Road, *Balakrishnan* 5741 (PBL, CAL); 27 km East-West Road, *Hore* 6770 (PBL, CAL); 39 km East-West Road, *Hore* 8207 (PBL).

Distribution. Andaman and Nicobar Islands, Thailand, Combodia, Vietnam, Taiwan, Malaya, Java, the Philippines and New Guinea.

28. **Thelasis pygmaea** Lindl. in J. Linn. Soc. 3: 63. 1859; Hook. f. Fl. Brit. India 6: 86. 1890; Yoganarasimhan *et al.* in Curr. Sci. 50: 284, 1981.

Small epiphyte; flowers small, crowded, pale green. Rare in roadside forests and edges of forests.

Flowers. April-May.

Fruits. Not known.

Specimens: North-South Road, near Campbell Bay, *Simhan et al.* 659 (RRCBI).

Distribution. NE India, Sikkim, Nicobar Islands, Nepal and Burma.

29. **Thrixspermum hystrix** (Bl.) Reichb. f. in Trans. Linn. Soc. 30: 14. 1874. *Dendrocolla hystrix* Bl. Bijdr. 291. 1825.

Epiphyte; inflorescence arising directly from leaf axils; stalk 4-6 cm long; flowers yellow; fruits 6.5-8 cm long, pointed at both ends. Rare in dense inland forests.

Flowers. May-June.

Fruits. July-August.

Specimens. Laful, *Hore* 8782 (PBL).

Distribution. Andaman and Nicobar islands, Burma, Thailand, Malaya, Sumatra, Java and Borneo.

30. **Trichoglottis cirrhifera** Teysm. & Binn. in Nat. Tijdschr. Ned. 493. 1853.

Epiphyte; flowers solitary, axillary; sepals and petals pinkish brown but labellum white with 2-lilac spots. Rare in beach forests.

Flowers. March.

Fruits. Not known.

Specimens. Campbell Bay, *Thothathri & Banerjee* 11307 (CAL).

Distribution. Nicobar Islands, Thailand, Malaya and Java.

31. **Trichoglottis orchidea** (Koenig) Garay in Bot. Mus. Leafl. Harvard Univ. 23(4): 209. 1972. *Epidendrum orchideum* Koenig in Retz. Observ. Bot. 6: 48. 1791.

Epiphyte, pendulous; flowers solitary arising from a little above of the leaf; flowers *c.* 1.5 cm long; sepals and petals reddish orange; lip white with pink spots at middle; spur white. Frequent in shaded inland forests; can be cultivated in greenhouses.

Flowers. August-February.

Fruits. Not known.

Specimens. Campbell Bay, *Balakrishnan* 2912 (PBL, CAL); 41 km on East-West Road, *R. P. Dwivedi* 7870 (PBL).

Distribution. Peninsular India, Nicobar Islands and Malaya.

32. **Vanilla andamanica** Rolfe in Kew Bull. 237. 1918.

Climber; leaves 15-20 × 3.5-4.5 cm, opposite, acuminate; capsule 15 × 2.5 cm, green. Common in shaded places in inland forests. The capsules can be used for extraction of *Vanilla* essence if properly cured; potentially useful for cultivation.

Flowers. April-June.

Fruits. July-August.

Specimens. 20 km on North-South Road, *Balakrishnan* 3833 (PBL, CAL, L)

Distribution. Endemic to Andaman and Nicobar Islands.

33. **Vrydagzynea albida** (Bl.) Bl. in Orch. Arch. Ind. 75, t. 19. f. 2. 1858; Hook. f. Fl. Brit. India 6: 97. 1890.

Etaeria albida Bl. Bijdr. 410. 1825.

Terrestrial, decumbent herb, *c.* 20 cm; leaves alternate; flowers terminal and condensed together, white. Rare along shaded streamsides on clayey loam.

Flowers. July-August.

Fruits. September-October.

Specimens. 37 km on East-West Road, on Path to Shompen village, *Balakrishnan* 3979/1 (PBL).

Distribution. Great Nicobar Islands, Bangladesh, Burma, Thailand, Vietnam, Malaysia, Indonesia and the Philippines.

PHYTOGEOGRAPHY

The phytogeographical relationship of the flora of Great Nicobar Island was not sufficiently known to the botanical world. The conjecture of Jacobs (1978), that the flora may be closely related to the Sumatran flora, is now found to be true. Based on the Orchids we find that the floristic affinities of the island are predominantly Indonesian and Malaysian and to some extent related to Burmese-Thailand elements. From the geographic situation of the island, the Malaysian and Indonesian elements are certainly to be expected in its flora.

Rapid accumulation of data regarding the orchid elements in this island and those of adjacent regions or countries greatly help us for a better understanding of the phytogeography of individual genera and species. It is now known that some genera are highly developed in distant regions but have single or a few representatives in the Malaysian region. Thus, *Cleisostoma uraiensis* earlier reported only from the Philippines, Taiwan and Formosa, is now found in fairly good populations in this island.

The orchids of Nicobar Islands show closer affinities with the Indonesian rather than Burmese-Andamanese elements. A few endemic species like *Eria bractescens* var. *kurzii*, *Phalaenopsis speciosa*, *P. speciosa* var. *tetraspis*,

Pomatocalpa andamanicum, Pteroceras berkeleyii and *Vanilla andamanica* occur both in Andaman and Nicobar group of islands. While *Aerides emericii* is restricted to the Nicobar group of island. *Anoectochilus nicobaricus* is restricted to the Great Nicobar island only.

Representatives of even more widely distributed species such as *Corymborkis veratrifolia, Dendrobium crumenatum, Goodyera procera, Luisia teretifolia, Pholidota pallida* and *Vrydagzynea albida* which extends up to Sri Lanka and peninsular India occur in this island. Some of these reach even the Himalayan regions also. *Spathoglottis plicata* is distributed almost throughout Malaysia, but does not extend northwards beyond Tenasserim in Burma. *Thelasis pygmaea,* a Himalayan species has been recently discovered from this island.

Except for *Spathoglottis plicata* (up to 100 m altitude), there is no altitudinal restriction for orchid habitats in the island. *Phalaenopsis speciosa* prefers a rather humid climate.

Conservation

The conservation of threatened species serves the positive purposes of providing genetic reservoirs, making significant contributions to modern agriculture, horticulture, pharmaceuticals and industrial processes in all parts of the world.

Human activities threaten some species and habitats more than others. As man's number increases and as each generation becomes more demanding, his environment and plant heritage will be affected. In this process man finds himself creating inexorable changes. In case of orchids, Beckner (1979) estimated that a possible 200 billion orchid plants are being destroyed every year due to human activities either through agricultural land clearing around the world, or collection for horticultural trade. Naturally, the need for conservation of orchid species is of paramount importance today. Many articles have been written (Ayensu 1975, Hunt 1968, Melville 1971, Peterson 1974, Pradhan, M. G. 1974, Pradhan, U. C. 1975), expressing intense concern and awareness of the orchid conservation problems. As a major step on conservation strategy and its execution and regulation of trade in wild orchids, the criteria discussed by Ayensu & Defilipps (1981) are worth following.

Though the Great Nicobar Island is small with an area of about 1045 sq. km, there exists many valuable wild orchids in the primary forests, occupying about 85% of the land area. At present only about 40% of the land area has been botanically explored and this itself yielded about 33 orchid taxa so far. No doubt more species would be collected when the unexplored areas are intensively surveyed.

Despite our limited knowledge about the genetic reservoirs, it is a certainity that this island contains germ-plasm materials of many wild relatives of cultivated species in localized pockets. Hence their conservation *in situ* is indispensible and simultaneously it is necessary to ascertain frequently their protection status also. The primary objective of a rational conservation policy is to preserve viable population of as many species as possible that inhabit the pristine primary forests. To achieve this the following steps are suggested :

1) To preserve and protect a large area, rather than only small pockets of habitats. This is easy because three fourths of the forest area of the island is still virgin. It should be effectively buffered against human onslaught and natural disasters. For this a large area of primary virgin forests should be declared as Biosphere reserve with sufficient buffer zone around.

2) To check the growth of human population by putting a complete stop on any further settlement on the island.
3) To maintain in botanic gardens, species suggested for ornamental propagation along with their range of genetic diversity is necessary. This is extremely important as emphasized by Schöser (1977).
4) To conduct field research and data collection on pollination biology of orchid species is another interesting aspect which can be done successfully only in this undisturbed wild conditions.

Only through this, it would be possible to save the rare valuable species of orchids of Great Nicobar Island.

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IS HABITAT DESTRUCTION IN INDIA AND PAKISTAN BEGINNING TO AFFECT THE STATUS OF ENDEMIC PASSERINE BIRDS ?[1]

A. J. GASTON[2]

The status and distribution of endemic passerine birds in India and Pakistan was examined to test the hypothesis that, in areas where human degradation of natural ecosystems is very pervasive, continental passerine species may become vulnerable to extinction. Species were classified according to their distribution, habitat saturation and abundance. The initial hypothesis was supported by the evidence and Pakistan was identified as an area affected particularly badly.

INTRODUCTION

Interest in the fate of endangered birds has centred mainly on large, spectacular species, such as the Great Indian Bustard *Choriotis nigriceps* and the Siberian Crane *Grus leucogeranus,* or insular forms such as the Laysan Finch *Psittirostra cantans* or the various Hawaiian Honeycreepers (Halliday 1980). Small continental species do not generally merit such concern with a few prominent exceptions (Kirtland's Warbler *Dendroica kirtlandii,* Noisy Scrub-bird *Atrichohrnis clamosus*).

The resilience of continental passerine species compared with non-passerines stems from the high densities that they maintain, allowing adequate populations to survive in relatively small patches of habitat. However, with the continuing conversion of ecosystems from natural to man-made configurations, we may anticipate the fragmentation of species populations sufficient to qualify for the attention of conservationists.

Because of the antiquity of human settlements and cultivation in India and Pakistan (Thapar 1966, Allchin & Allchin 1968) and the very high density of population maintaining over many centuries over most of the area (e.g., Bose *et al.* 1965), natural ecosystems occurring in the Indo-gangetic plain and the Deccan plateau have been virtually eradicated. They have been replaced, in areas suitable for agriculture, with intensive cultivation, and in most other areas with derelict scrub and semi-desert communities (Eckholm 1979, Baig 1980).

I have examined the status of endemic passerines in India and Pakistan to test the hypothesis that species characteristic of the heavily disturbed lowland ecosystems of the Indo-gangetic plain and the peninsular India may show signs of increased rates of extinction, or vulnerability to extinction. I have based my assessment on personal observations made over the last twelve years throughout India and Pakistan, augmented by those of T. J. Roberts for Pakistan, combined with descriptions of status given by Ali & Ripley (1969-74) and others. I have confined my appraisals of status to Pakistan and India east to about West Bengal which is the area over which my own experience extends and I have omitted

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Sri Lanka, with its varied endemic avifauna, and the Andaman Islands.

I have classified each species according to three criteria :

(1) *Distribution.* Each species is assigned to one of four eco-geographical areas (see below) on the basis of its present distribution.

(2) *Habitat saturation.* Species are classified as (a) continuous, present in all suitable habitat; (b) local, absent from some areas of apparently suitable habitat within its overall range; (c) very local, present in only a few isolated pockets.

(3) *Abundance.* Species are ranked based on numbers generally encountered in the course of a day's birdwatching in suitable habitat : (a) abundant, >100; (b) common, 10 – 100; (c) scarce, 1 – 10; (d) rare, < 1.

Inevitably, I have had to be somewhat subjective in my choice of "endemics". Although I have only considered Pakistan, India and Western Nepal in my appraisals of status, I have dealt with all species which are endemic to the temperate western Himalayas, including some which extend into Afghanistan, and some species of the Indo-gangetic flood plain which extend into lowland Burmah.

Distribution and Ecology

I have divided the endemic species under consideration into four groups based on present distributions and ecology :

(1) Species with distribution centred on the Indo-gangetic plain associated mainly with waterside vegetation, and hence presumably forming part of the fauna of the seasonally inundated flood-plain forests and grasslands that must originally have covered much of the plains prior to the introduction of agriculture. This area now supports a very high density of human population; more than 400. km^{-2} (Bose *et al.* 1965).

(2) Species found mainly in the dry rolling plateau of the Deccan. This area was formerly covered in deciduous forest, particularly Teak *Tectona grandis.* Although considerable areas of forest remain, these are much affected by disturbance, particularly grazing. Large areas have been felled, some of which have been replanted as monocultures, but large areas support only a derelict open scrub (Baig 1980).

(3) Species occurring in the high rainfall moist-deciduous and evergreen forests of southwest India and the Western Ghats. This forest has been much reduced by commercial timber extraction and the construction of hydro power dams, but moderate areas of seminatural forest remain except in the narrow strip of coastal plain where natural forest has been practically eliminated.

(4) Species occurring in the temperate forests of the Himalayas and associated mountains as far east as central Nepal. This encompasses species living at altitudes above those characteristic of species found in the adjacent plains (area 1), but below those characteristic of arctic-alpine habitats, most of which extend into Tibet and central Asia (Vaurie 1972). Forests in this zone consist mainly of mixed evergreen oaks (*Quercus* spp.) and conifers. Although large areas of forest have been destroyed by timber extraction, there are still substantial areas of intact natural forest (Gaston *et al.* 1983).

Results

The endemic species considered are listed

TABLE 1

STATUS OF ENDEMIC PASSERINE SPECIES IN INDIA AND PAKISTAN, SOUTH OF THE GREAT HIMALAYAN RANGE

Species	Distribution (Area #)	Habitat Saturation	Abundance	Notes
Sturnus contra	1	Continuous	Abundant	Well adapted to man-made environments
Acridotheres ginginianus	1	Continuous	Abundant	
Chrysomma altirostre	1	Local	Rare	Western race, *C. a. scindicum* disjunct, probably rare
Turdoides earlei	1	Local	Common	Western race, *T. e. sonivius* very local, probably not very numerous
Prinia burnesii	1	Very local	Uncommon	Western race, *P. b. burnesii* disjunct, probably not numerous
Saxicola leucura	1	Very local	Uncommon	
Passer pyrrhonotus	1	Very local	Uncommon	
Ploceus megarhynchus	1	Very local	Uncommon	
Ploceus benghalensis	1	Local	Common	
Pericrocotus erythropygius	2	Local	Uncommon	
Mirafra erythroptera	2	Local	Uncommon	Abundance hard to judge because species is very similar to *M. assamica*
Pycnonotus xantholaemus	2	Local	Uncommon	
Pycnonotus luteolus	2	Local	Uncommon	
Turdoides malcolmi	2	Continuous	Common	Well adapted to agricultural land
Parus nuchalis	2	Local	Uncommon	
Estrilda formosa	2	Local	Uncommon	
Prinia buchanani	½	Continuous	Common	
Chaetornis striatus	2	Very local	Uncommon	Skulking, status may be better than it appears
Saxicola macrorhyncha	2	Very local	Rare	
Cercomela fusca	½	Local	Common	
Pycnonotus priocephalus	3	Local	Uncommon	
Turdoides subrufus	3	Local	Common	Often numerous on tea estates
Garrulax cachinnans	3	Local	Common	
Garrulax jerdoni	3	Local	Common	
Myiophoneus horsfieldii	3	Continuous	Common	

Muscicapa pallipes	3	Local	Uncommon	Hard to see because of
Muscicapa nigrorufa	3	Local	Uncommon	dense habitat
Schoenicola platyura	3	Local	Rare	Skulking, possibly commoner than appears
Brachypteryx major	3	Local	Uncommon?	Common according to Ali & Ripley (1972)
Nectarinia minima	3	Continuous	Common	
Turdoides nipalensis	4	Very local	Common	
Garrulax variegatus	4	Continuous	Common	
Phylloscopus tytleri	4	Local	Uncommon	Hard to identify
Phylloscopus subviridis	4	Local	Common	
Parus melanolophus	4	Continuous	Abundant	
Aegithalos leucogenys	4	Local	Uncommon	
Aegithalos niveogularis	4	Continuous	Uncommon	
Mycerobas icterioides	4	Continuous	Abundant	
Callacanthis burtoni	4	Very local	Common	
Pyrrhula aurantiaca	4	Local	Uncommon	

in Table 1. Three of the species of area 1 comprise more or less disjunct races split between the Indus and Ganges valleys. In all cases the western (Indus) populations are local or very local and may warrant conservation measures soon, particularly *Chrysomma altirostre. Passer pyrrhonotus* is confined to the Indus but appears to have adapted to tree-lined irrigation canals (T. J. Roberts, *pers comm.*). *Ploceus megarhynchus* is found only in a few localities in northern Uttar Pradesh in seasonally inundated grasslands (Ali & Crook 1959) and the status of this species invites concern.

In area 2, *Saxicola macrorhyncha* and *Chaetornis striatus* seem sufficiently uncommon to require attention, although the latter is a skulking species, easily overlooked, and may be more common than it appears. The minivet, *Pericrocotus erythropygius,* has certainly become less common around Delhi in the last 50 years and its status elsewhere may warrant investigation (cf. Basil-Edwards 1926, Ganguli 1976, *pers. obs.*). Three other species appear to be local and uncommon, but area 2 is very large and with many remnant patches of forest it is hard to assess the status of forest birds such as *P. erythropygius, Parus nuchalis* and *Pycnonotus xantholaemus.*

The status of species in area 3 is easier to assess than that of species in area 2, because the area of typical forest vegetation is much smaller and extensive surveys have been carried out recently by Kerala Forest Research Institute and Calicut University researchers. Only *Schoenicola platyura* appears rare, but as in the case of *Chaetornis striatus,* the species is hard to locate and may be commoner than it seems. Five other species are local and uncommon and could easily become vulnerable to extinction with further reduction of their preferred habitats.

Area 4, like area 3, can be fairly accurately assessed because it is small and has been frequently visited by ornithologists during the past 20 years (e.g., Gaston *et al.* 1981). The status of *Phylloscopus tytleri* is hard to judge because the species is very difficult to identify in the field; it may be fairly common within its small range. *P. subviridis* is sufficiently common in its winter range in the north Indian plains to indicate that it is fairly numerous somewhere, although its breeding area is not

well known. Probably none of the species from area 4 warrant concern at present.

Discussion

The initial hypothesis that areas where alterations to the natural ecosystems have been greatest will have the greatest proportion of species which are local/very local and uncommon/rare seems to be supported by the present analysis (Table 2). Areas 1 and 2, the most intensively cultivated and those supporting the highest human population densities have 55% and 72% of their endemics in the local/very local and uncommon/rare categories, compared with only 30% for area 4. These differences are not statistically significant. However, five species from areas 1 and 2 are very local, compared with only one in the other two areas.

Table 2

Proportion of species in four eco-geographical areas of the Indian subcontinent falling in different categories of distribution and abundance

Area	Local/V. local Uncommon/ Rare	Local/V. local/ Common Continuous/ Uncommon	Continuous/ Common Abundant
1	5(55%)	2	2
2	8(72%)	1	2
3	5(50%)	3	2
4	3(30%)	4	3
Total	21	10	9

Combining Areas 1 and 2 (highly disturbed), and 3 and 4 (less disturbed) and columns 2 and 3 (not vulnerable), Chi^2, with Yate's correction = 1.6, $P > 0.05$.

The very local classification of species in areas 1 and 2 does not indicate that their ranges are smaller or their populations lower than the local species found in other areas. What it does indicate is that these species occupy a much smaller proportion of the apparent potential habitat. Several of the endemic species of area 3 have very small ranges and populations may number only a few thousand pairs (e.g., *Garrulax* spp., *Muscicapa nigrorufa, Brachypteryx major*). However, this is clearly a function of the relatively small area of natural evergreen forest in southwest India.

One point that emerges from consideration of endemic species in areas 1 and 2 is that those occupying the Indus basin appear to be faring worse than those in the Ganges basin, with one species, *Saxicola macrorhyncha,* possibly vulnerable to extinction and two of the endemic races, *Chrysomma altirostre scindicum* and *Prinia b. burnesii,* perhaps also vulnerable. It is tempting to point to a connection with the very early establishment of urban civilization in the Indus valley (Allchin & Allchin 1968), but it seems more likely to be related to the greater aridity of the Indus valley generally and the smaller area involved, hence providing fewer remaining refuge areas.

Acknowledgements

I would like to thank Kamal Islam and T. J. Roberts for information on birds in Pakistan, and the latter also for detailed criticism of an earlier draft. I also received useful comments from P. J. Garson, B. Beehler and S. Dillon Ripley. My wife, who accompanied me in my travels to the uttermost parts of India, has always been an ideal companion, making much of my work possible.

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FOOD AND FEEDING HABITS OF FINGERLINGS AND JUVENILES OF MAHSEER (*TOR PUTITORA* HAM.) IN NAYAR RIVER[1]

PRAKASH NAUTIYAL
AND
M. S. LAL[2]

(*With three text-figures*)

The food and feeding habits of the fingerlings and juveniles of *Tor putitora* inhabiting river Nayar were studied for one year.
Observations on the nature of food and feeding habits indicated them to be "monophagic" and "column feeder". Inspite of the fact that the RGL values supported its omnivorous habit, the percental value of insect food item and their occurrence in 5% of the fishes clearly indicated a *"Carnivorous"* habit.

INTRODUCTION

The present contribution deals with the food and feeding habits of Garhwal mahseer (*Tor putitora* Ham.). Recent contributions in this field are by Das & Pathani (1978), on the adaptation of alimentary tract in relation to the feeding habits, Pathani & Joshi (1979) on the food and feeding habits of the fingerlings of *Tor tor* and *Tor putitora,* and Badola & Singh (1980) on food and feeding habits of fishes belonging to genera *Tor, Puntius* and *Barilius.*

Bearing in mind the significance of such data it was felt desirable to investigate the food and feeding habits of the fingerlings and juveniles of *Tor putitora* inhabiting river Nayar. This river was chosen for study as it harbours a large population of mahseer juveniles throughout the year suggesting its high productivity (Nautiyal & Lal 1978).

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MATERIALS AND METHODS

For analysing the food and feeding habits of the mahseer, fish were procured at regular monthly intervals for one year from river Nayar. After measuring the length and weight the entire specimen was fixed in 5-7% formalin and brought to the laboratory. The fish available during these months ranged from 40.0 mm to 354 mm. Those ranging from 40.0 mm to 70.0 mm were considered as fingerlings and those above, as juveniles.

After recording the morphometric data, the fish was dissected and gut contents were examined for food habits. The fish being a typical cyprinid lacks the conventional stomach and as in others possesses an intestinal swelling in the anterior part, called "the intestinal bulb." The entire gut was taken out and moisture was removed by blotting paper. The total length of the gut was measured for determining Relative Gut Length (RGL) which was calcu-

lated as the ratio of intestinal length to total body length. The "intestinal bulb" was then separated, weighed and then reweighed after evacuating its contents into a petri-dish. Their difference gave the weight of the entire gut contents. Volume of the food was recorded by displacement method. From the average data thus obtained the "Gastro-Somatic Index" (GSI) was determined for each fish to study the seasonal variations in food by the formula:

$$\text{GSI} = \frac{\text{Weight of the stomach contents}}{\text{Weight of the fish}} \times 100$$

The percentage of food composition was detected by the points method. While allotting points to the different food items the size of the fish and state of the intestinal bulb were taken into consideration. Points were allotted on their relative volumes as assessed by visual estimation and converted into percentages.

The feeding intensity was assessed by classifying the intestinal bulbs as Full, $\frac{3}{4}$ Full, $\frac{1}{2}$ Full, $\frac{1}{4}$ Full, Poor and Empty, and were awarded 20, 15, 10, 5, 2.5 and 0 points respectively, depending on the state of distention of stomach and amount of food in it. "Feeding Index" (Tham Ah Khow 1950) was calculated to express the feeding intensity.

The annual percentage of occurrence of the different food items in the guts was assessed by the Occurrence method (Allen 1935, Frost 1939, 1946). They were graded by the "Index of Preponderance" (Natrajan & Jhingran 1961).

Macroscopic and Microscopic examinations of the gut contents were made to identify the food items. In spite of this, to ensure the qualitative analysis of the fish's diet, the intestinal as well as rectal portions were also examined.

Feeding habits were observed in the field but this was possible only during winter and early summer when water remained crystal clear most of the time.

Observations

Food and its nature

The examined gut contents of *Tor putitora* consisted of insects, their larvae and nymphs along with plant debris, worms, sand and fish remains. Insects formed the highest percental value (Fig. 1) as compared to the other items, annually.

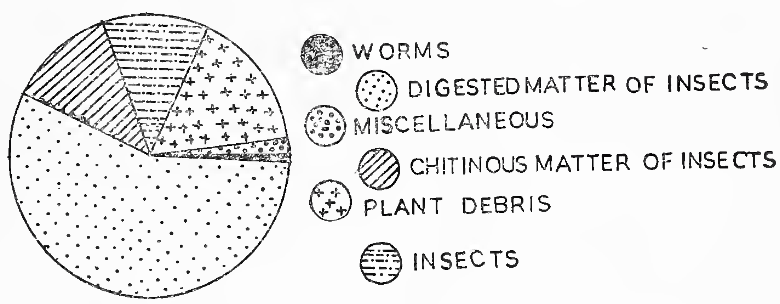

Fig. 1. Pie diagram showing percentage annual feed of *Tor putitora*.

1. *Insects* : Insects constituted the major part completely intact or slightly damaged insects, their larvae and nymphs were categorised as insects, their undigested remains which included legs, wing pads etc. were termed as chitinuous matter, and the digested portion which had the look of white torn flesh was identified and classified as the digested matter of the insects. In the present paper, in order to make an easy interpretation all the three items were grouped as insect matter. It was recorded that 73.5% of the fish had insect matter in their guts.

The insects constitute 81.7% of the gut contents annually. Microscopic and macroscopic examinations of the gut contents revealed that the fish feeds on the nymphs of may-flies and stone-flies, larvae of caddis-flies, and other aquatic insects along with the adults of water bugs.

2. *Plant debris* : During monsoon the surface run-off along with high velocity of water in

the streamlets bring either broken twigs or even branches of shrubs and trees growing on their banks, into the river. Small, granular particles were present in the intestinal bulb and identified as epidermal cells of plants and was thus termed as "plant debris". It constituted 15.9% of the gut contents annually and was present only during the month of August, 1980 and July, 1981 in 7.7% of the fish collected.

3. *Worms* : The worms which were often present in the gut have been considered as gut contents, but not as food, for they were parasites. This was confirmed by dissecting out the alimentary canal of the freshly killed specimens in which the worms were found to be alive. They were in higher percentage in the intestinal bulbs possessing only digested matter. They constituted 0.8% of the gut contents, annually and were present in 12.0% of the fish.

4. *Miscellaneous* : The items included in this category were sand and fish remains (vertebrae, scales, dermal bones etc.) which constituted a major part as compared to fish remains which were found only during May. These items were present in 6.8% of the fish.

Feeding Intensity : The feeding intensity as is evidenced by the "Feeding Index" varies from month to month (Fig. 2). It was also observed to differ with the length of the fish (Table 1) for the fishes ranging from 40.0-90.0 mm were observed to possess higher feeding intensity. The intensity however fell after the fish attains the length of 190.0 mm or more.

TABLE 1

FEEDING INDEX VALUES FOR DIFFERENT LENGTH GROUPS OF *Tor putitora*

40.0-90.0	64.9
91.0-140.0	34.3
141.0-190.0	40.0

Relative Gut Length: The relative gut length ranged from 0.819 to 0.918 in fingerlings and from 1.056 to 1.825 in the juveniles (Table 2).

TABLE 2

RELATIVE GUT LENGTH VALUES FOR *Tor putitora* FROM RIVER NAYAR

Months	RGL Values
August	1.056
September	1.406
October	0.819
November	0.868
December	0.918
January	1.159
February	1.454
March	1.301
April	1.556
May	1.675
June	1.825
July	0.835

DISCUSSION

The food and feeding habits of *Tor putitora* inhabiting high altitude Kumaun lakes and the hill streams of Garhwal Himalayas have been worked out by some authors.

Based on the Relative Gut Length values, position of the bile duct and percentage of the food items, Das & Pathani (1978) have considered it to be an "herbi-omnivore". Its fingerlings have been declared by Pathani & Joshi (1979) to be of "zoophagus nature". Badola & Singh (1980) have assessed *Tor putitora* to be a "carni-omnivore". However, observations our differ from those made by these authors. The investigations revealed that the insect matter ranked first and was considered as the "basis food" (Nikolsky 1963)

of the fingerlings as well as of the juveniles. Since the plant debris and the fish remains were consumed only in time of need, they were

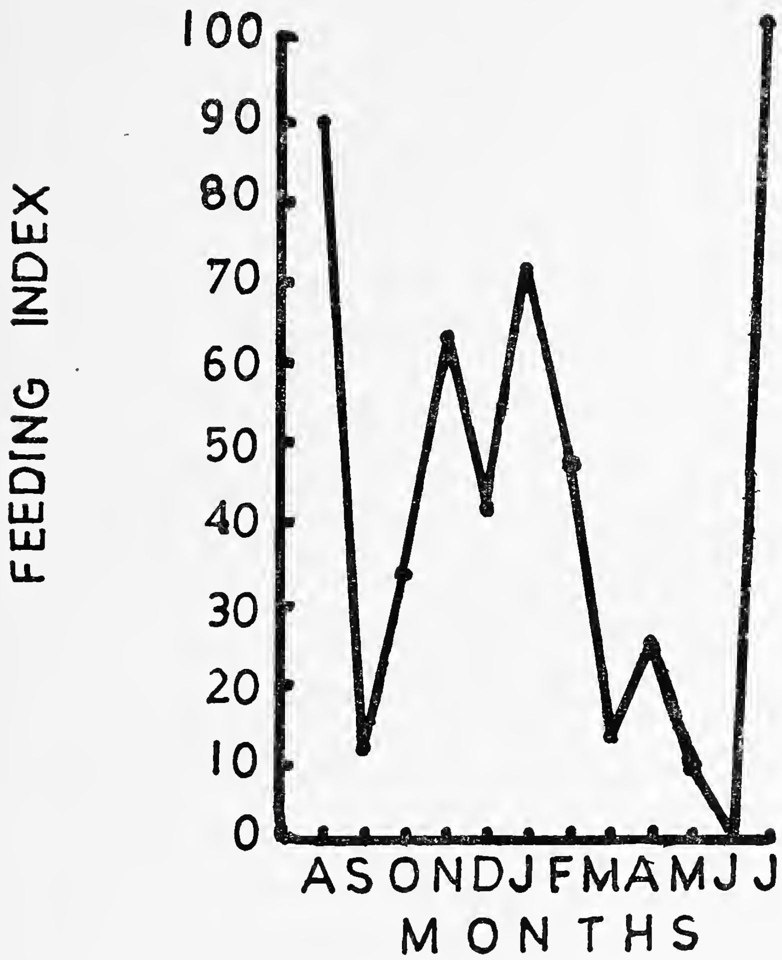

Fig. 2. Variations in the feeding intensity of *Tor putitora*.

categorised as "obligatory food" (Nikolsky 1963). Among the insects the Ephemeropteran

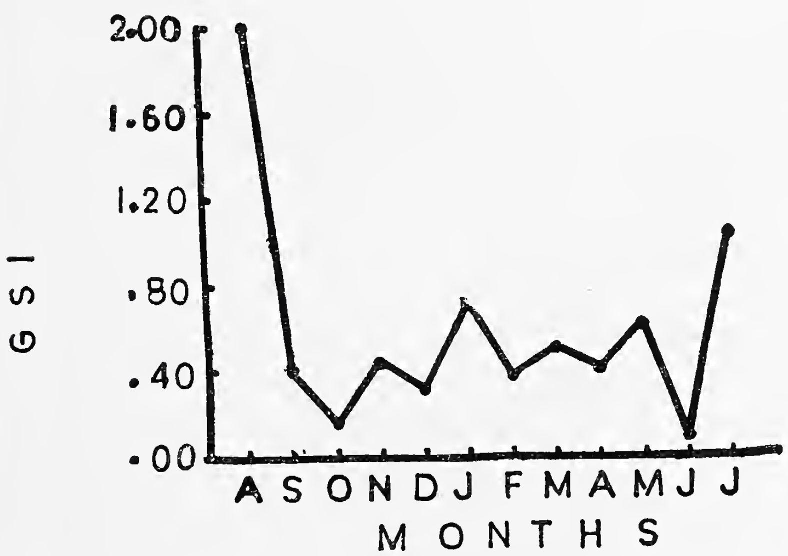

Fig. 3. Gastro-Somatic Index. Quantitative variations in the Diet of *Tor putitora*.

nymphs dominated, followed by Trichopteran and other insect larvae. Plecopteran nymphs were present occasionally, while hemipteran and coleopteran adults were rarely found.

The GSI exhibited no marked seasonal variation throughout the year, except for the month of August (Fig. 3) which can be attributed to intensive feeding by the young ones.

Feeding intensity has been worked out by some authors applying the fullness method (Frost, 1939, and a few others). Hynes (1950) has determined the extent of feed by considering the state of stomachs. Tham Ah Khow (1950) has propounded the "Feeding Index" based on the number of 3/4 and full stomachs while Lal & Dwivedi (1969) have determined the feeding intensity by the number of empty stomachs. The feeding index has been successfully applied by Venkataraman (1960) and Toor (1964). In the present case the maximum feeding intensity in *Tor putitora* was recorded during July and August. During these two months the fingerlings were available which evidently being young stages fed voraciously (Table 1). However, if the juveniles are taken into consideration, from September onwards the index exhibits a peak in January after which it gradually went down to minimum in May.

Feeding habits

The fingerlings were mostly found in the lee of flooded pools during monsoon and thus feed on some plants which get submerged in them. However, the juveniles feed actively in shoals during early morning hours. They were observed to feed on the river margins but switched over to the middle section during day. While feeding on insects they scrape the stones with the help of their lower jaw. Juveniles which have attained larger size were usually solitary in habit and inhabited the deeper pools.

The fish is thus "marginal-cum-mid" or "column feeder."

The mid- or bottom feeders may be herbivores, omnivores, or carnivores in nature (Das & Moitra 1963). The Garhwal mahseer, as is evidenced by the inferior pharyngeal teeth (Nautiyal *et al.* 1980) and the RGL values, seems to be omnivores in nature. If the percental values of the gut contents are taken into consideration its "insectivorous" nature cannot be denied. The term insectivore (Khanna & Pant 1964) has been included in the category of carnivores (Das & Moitra 1963).

In the case of *Tor putitora,* insect matter constituted 81.7% and the plant matter 15.9% of the annual feed. The latter was occasionally present in the guts examined (during July and August) We thus concluded that the fish under investigation is a *"Carnivore"* by habit. The contradiction thus arising due to the comparison of the actual dietry habits of the fish with the RGL values supports the view that the fish can adapt to the diet available in the particular environment (Steven 1930, Pillay 1953, Martin 1954, Kapoor 1958 and Singh 1966). Also, that it is not always possible to relate fish's diet to the length of the alimentary canal (Al-Hussaini 1949). The herbi-omnivorous nature of the Kumaon mahseer has been reported to be a peculiar example of evolutionary transition from herbivorous to omnivorous nature (Das & Pathani 1978). Naturally, the Garhwal mahseer too seems to be a similar case exhibiting changes in the food habits from omnivorous to carnivorous habits, an adaptation to the environment of the Nayar river, a spring-fed hill-stream.

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THE ENVIRONMENTAL LIMITATIONS AND FUTURE OF THE ASIATIC LION[1]

PAUL JOSLIN[2]

(*With six text-figures*)

These findings first appeared in a more expanded thesis form in 1972, and were distributed to the respective government and non-government agencies which had assisted in the study. At about the same time the shorter version given here was submitted for publication, intended as one of several papers to be prepared by the various research staff at the Gir Ecological Research Station that were to appear in a special issue of the Journal. However, for a number of reasons, not the least of which was funding, the project did not come to fruition.

More than a decade has since passed, during which time there has been great changes in the Gir Sanctuary. Thanks to far sighted government action, the numbers of lions are now up, the population of other wildlife are improved and the habitat is substantially richer and more luxuriant. However, rather than re-write the report to reflect the changes, it has been decided to publish the original version in order to best describe the conditions as they originally existed during the three year study period, and to report separately on the results of a more recent, but less exacting study, carried out over a period of less than one month.

INTRODUCTION

This study was undertaken because of an interest in investigating the problems and ways of conserving an endangered species. The Asiatic lion *(Panthera leo persica)* was chosen from the International Union of Conservation of Nature Resources list of rare and endangered species in 1966, in consultation with Dr. Lee Talbot, Mr. Noel Simon and others. It was thought to be a typical example of an endangered mammal because more than half of the recently extinct mammals were predators, and most of these were large (Talbot 1959). The Asiatic lion was suitable for an intensive study because, although rare, its distribution was concentrated into a single 1300 km area in Gujarat State, western India. There had also been repeated requests to have it investigated (Daniel 1956, Talbot 1959, Spillet, unpublished report; Indian board for wildlife in 1956).

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It is with pleasure that I acknowledge the financial help of several institutions which made this study possible. I am especially grateful to The Royal Society, the Smithsonian Research Foundation in collaboration with the Bombay Natural History Society, the Volkhart Foundation (WWF Project Number 198), the Children's Section of the World Wildlife Fund British National Appeal, and the Fauna Preservation Society for the monetary support which they so generously contributed. I thank

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I am grateful to my colleagues, Mr. K. T. B. Hodd, Dr. Stephen Berwick, Mr. Robert Grubh, Mr. Nicky Sanyal and Mr. Sanat Chavan, who were engaged in research in the Gir Sanctuary during parts of my stay, and who offered much assistance and consultation. Warm thanks are also extended to Dr. Lee Talbot, Dr. George Schaller and Prof. Dr. Paul Leyhausen, who kindly gave me advice in the field.

I appreciated the help of many temporary assistants, especially Miss Dorothy Brewster, Mr. K. S. Mohmed Bashirkhanji, Mr. Nata Mashru, Mr. Mohmed Sheikh, Mr. Hassan Sidi, Mr. Chondu Joshi, Geno and Bejal. Last but not least, I am very grateful to Dr. David Jenkins for his patient and encouraging supervision both in the field and at the University of Edinburgh.

Description and History

The Asiatic lion resembles the African with only a few apparent differences. Along the length of the abdomen it has a prominent fold of skin which seldom is found in African lions. Comparing the skulls, in African lions, as in all mammals, there is only one infraorbital foramen below the eyesocket on each side, while Todd (1965) found that in more than fifty per cent of skulls of Asiatic lions taken from the single remaining population there was pairing of either one or both of the infraorbital foramen (fig. 1). Behaviorally they are astonishingly docile and tolerant of visitors on foot, the means by which most visitors see them. A few lions have actually been touched in the wild. The adult males are responsible for nearly all the potential territorial advertisement, such as roaring, scraping or spraying of scent, whereas among African lions Schaller (1972) has found that such advertisements are by no means limited to the males alone.

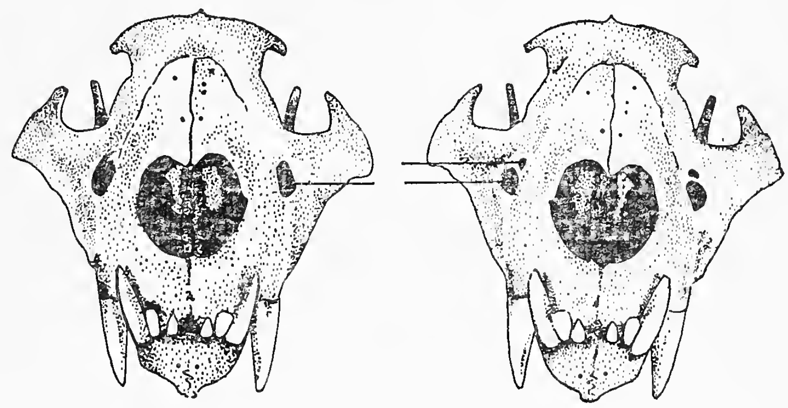

Fig. 1. Comparison of infraorbital foramen between lion skulls from Africa and from the Gir Sanctuary.

The range of the Asiatic lion once extended from Syria, across the middle east to eastern India (fig. 2). However between 1850 and 1900, when firearms came into popular usage, most of the lions were killed, although a few dwindled on in Iran until 1942 (Heaney 1943). Credit for the survival of lions in the Gir hills in Gujarat State, was due to the limited hunting permitted by the Nawab of Junagadh on whose land the lions existed. At the time of

Fig. 2. Known distribution since 1781.

independence the area was designated a reserve, and in 1965 it was upgraded to be called the Gir Forest Wildlife Sanctuary.

Population Size and Decline

In June 1968 the Gujarat State Forest Department undertook a census of the lion population and concluded that there were approximately 177 lions remaining within the 1265 sq. km. sanctuary and surrounding lands. This count was about 40 per cent lower than any of the previous counts within recent years. To verify their enumeration I made five estimates of the size of the lion population. Three estimates were ascertained from road counts, counts at waterholes and density assessments of known prides. The fourth and fifth assessments were extrapolated from an approximation of the total amount of domestic bovids consumed per year and two estimates of the amount of food required per lion per year. The object in making five estimates was to partially overcome the problem of known and unknown biases and sources of error associated with any one estimate. The average of the five determinations was 190, or not significantly different from the government count. That the government was also right in pointing out a decline was evident by the marked decrease in the lion's range. In 1955 half the lion population counted was found outside the present boundary of the reserve, while in 1968 only 17 per cent of the total lion population could be located outside. Moreover lions could no longer be found in the Girnar range to the north or in the Mithila range to the east where in 1955 they still existed.

Poisoning

The decline could not be attributed to hunting, as there had not been any for many years. Instead poisoning was blamed, especially by the news media. Lions were attacking domestic stock which resided both in and around the sanctuary, and occasionally the owners would retaliate by poisoning their losses, and allowing the lions to feed. However when I examined the government files on each case between 1963 and 1969 I found that poisoning was rare, or at least its discovery was rare, for only an average of one case of foul play was uncovered per year. Certainly such incidental cases would not bring about a reduction in the lion population. However poisoning was dramatic. It involved both adult lions and young. It brought about police action and court proceedings. In essence it lent itself to popular attention.

Overgrazing

When Dr. Lee Talbot visited the area briefly in 1956, he was aware even then that the lion population was declining, and he provided an alternative explanation. By standing in the middle of the sanctuary in the dry season one can see either a teak forest, or an acacia scrub forest. By moving more towards the edge of the sanctuary much of the forest gives way coincidental with the sharp build up in the concentration of domestic graziers. Outside the sanctuary one sees almost no forest. Talbot (1959) reported that the amount of overgrazing and associated misuse was so bad that within a mere 20 years the Gir Forest would be gone, and with it the lions. However he had come only at the height of the dry season, when conditions looked particularly bad. He did not have a chance to see how tenaciously the forest hangs on aided by the monsoon rains. So attuned had evolution adapted the Gir forest to the clockwork onset of the monsoon that in the weeks before its arrival more than 50 species of trees and scrubs would begin growing new shoots and fighting back.

From 1968 to 1970 Hodd (1970) monitored the effects of overgrazing by fencing some areas and comparing the amounts of growth inside and outside. During the first growing season five times as much vegetable biomass was produced inside the fenced plots compared with outside. In otherwords the sanctuary had not been so severely damaged as to be permanently impaired. Thus he concluded that it was unlikely that the destruction of the Gir habitat through overgrazing was the principal cause for the lion's decline in the short term. By, standing on top of the highest hill in Gir in the monsoon and seeing how extensive and productive the forest still appeared with 13 of the 20 year prediction having passed, it was apparent to me that perhaps a century or more would pass before overgrazing could totally destroy the forest. So another more important reason for the lions' decline had to be sought.

Cultivation

The most likely contender was the 'green revolution'. The replacement of grazing land by cultivation meant the displacement of range, cover and more importantly the wild and domestic animals upon which the lion depended for food. Black cotton soil, one of the best substrates for crop development, formed a major part of the surrounding low lying areas, and in a country where man was hungry it would have been surprising if these lands were not converted to crops.

I made several reconnaissance flights over the southern boundary of the sanctuary, which was fairly typical of the areas surrounding the sanctuary. It was only possible to take oblique aerial photos. In any single photograph, therefore, the actual amount of cultivated land existing below could not be determined. However by taking a large number of photographs at random so that any one land use had as much likelihood of being in the foreground or background as the next, and averaging the results, it was found that approximately 70 per cent was cultivated. Of that remaining only 13 per cent appeared suitable for lions — that is forest, scrub and riverside cover. The rest was largely denuded fragments of limited value to lions.

The 'green revolution' was in progress outside the sanctuary, and it was outside where the bulk of the lion population had disappeared since 1955. Where lions still existed on the outside was in the few remaining forested regions adjoining the sanctuary which had not yet been cleared for cultivation.

Within the sanctuary the extent of cultivation was very limited. By combining my findings from oblique aerial photos with estimates made by forest department surveyors in 1968 and 1970, and allowing for areas of overlap, I estimated that six per cent of the sanctuary was either cultivated or allocated for development. Such a limited amount of damage to the sanctuary was not of much consequence to the indigenous lion population. However, since much of the cultivation was in the processes of expanding, it is reasonable to assume that it would have serious repercussions if not curbed.

Size and Composition of Prey Population Within Sanctuary

In the dry season some 49500 ungulates were estimated to be using the sanctuary daily, consisting of approximately 11 per cent wild ungulates and 89 per cent domestic bovids. The species composition was 53 per cent buffalo, 30 per cent cow, 5 per cent oxen, 8 per cent spotted deer and 3 per cent other wild and domestic species, including nilgai, sambar, wild boar, four-horned antelope, Indian gazelle, camel, horse, sheep and goat.

The wild ungulate population was assessed by night road counts in 1968 and the species composition crosschecked with casual counts made mostly in daytime, and counts at waterholes. Extrapolating for the sanctuary I estimated there were approximately 5600 wild ungulates. The following year Berwick repeated the road counts. His population estimate did not differ significantly from my own (Berwick and Jordan 1971).

The number of resident domestic stock was assessed by counting the animals in a sample of 20 villages during the evening milking period when all were corralled, and extrapolating for the sanctuary. A second determination was made by extrapolating from the 178 km sampled area to that of the total sanctuary. The two figures, which were within six per cent of each other, averaged 19650. Similar assessments were made for the forest settlement village stock which bordered the sanctuary and the non-resident stock which grazed within the sanctuary for part of each day. These totalled 5550 and 18700 animals respectively.

Food Habits Based on Faecal Analysis

I next looked at the diet of the lion as reflected in their faeces. Over 1800 carnivore scats of unknown species origin were collected. From a sample of 95 scats of known species origin, be it lion, leopard, hyaena or dog, it

was found that 90 per cent of the lion faeces measured 45 mm or more in diameter, while the other species were all smaller. Applying this dimension to the unknown sample, I then selected 480 faeces which I could assume were of pure lion origin. The next task was to identify the prey species which they contained from the remnants of hair.

After trying various methods, it was found that hair cross sections were the best means for identification. For example buffalo hair was characterized by its oval shape, grey medulla, slight pigmentation of the cortex due to cortial pigment granules, and an average cross sectional length of about 90 microns. Nilgai hair, in contrast, was less oval in shape, with a black medulla which was slightly pointed and flattened on one side, a cortex without pigment, and an overall cross sectional length averaging 140 microns. Sambar hair was highly elongated in cross section, the medulla divided into 30 or more segments, and occupying most of the cross section leaving only a thin cortex. The cross sectional length averaged 300 microns or more.

After working out a reliable key and applying it to the sample of lion faeces, it was found that some 75 per cent contained hair of domestic stock, which was not at all surprising considering the preponderance of domestic stock which had been shown to exist in the sanctuary.

Lion Predation on Domestic Stock

I next offered rewards to cattle graziers for cooperating in an inquiry into their domestic losses. Those graziers who reported lion kills within 24 hours of the event, and took me to see them were given ten rupees. This was a very productive part of the study. Information was gathered on some 330 carcasses and data established on some 18 variables, ranging from type of prey, age, time of attack, where killed in relation to the village of origin, where killed in the sanctuary, amount of carcass eaten, etc. With the aid of a 360/50 computer a systematic analysis of the data was made by associating each variable against each of the other 17. Those results which are of primary importance are discussed here.

Prey selection : Cow, buffaloes and to a lesser extent oxen were attacked more often than other domestic prey. In a sample of 330 animals 40 per cent were cows, 41 per cent were buffalo, 13 per cent were oxen and only 6 per cent consisted of the combined totals of camel, sheep, goat, horse and dog. Because the latter five species were very much in the minority in the live population, their poor representation in the kill record was to be expected. However, sheep, goat, and dog were all small prey of little or no value to the herdsmen, and hence might not have been considered worth reporting (although I paid an equal reward for all cases investigated). It was illegal to graze sheep within the sanctuary, which may have contributed to there being no reports of sheep loss.

Sixty-one per cent of bovid kills were from sanctuary villages, 25 per cent from villages outside the sanctuary, and 14 per cent from forest settlement villages. Stock from sanctuary villages remained inside the sanctuary, and hence were always available to lions, while stock from outside villages came into the sanctuary for only variable parts of each day, and never at night, thus accounting for their poor representation among lion kills. Few animals were from forest settlement villages probably because they contained only 10 per cent of the available prey population.

The three village classes, sanctuary nesses,

forest settlement villages and villages outside the sanctuary, also kept different proportions of cows, oxen and buffalo. To determine the lions' food preferences, I compared the kill records with the bovid stock maintained by each class of village. While predation always reflected prey abundance to some extent, cow and oxen were preferred over buffalo in all three village classes (fig. 3). The probability of obtaining

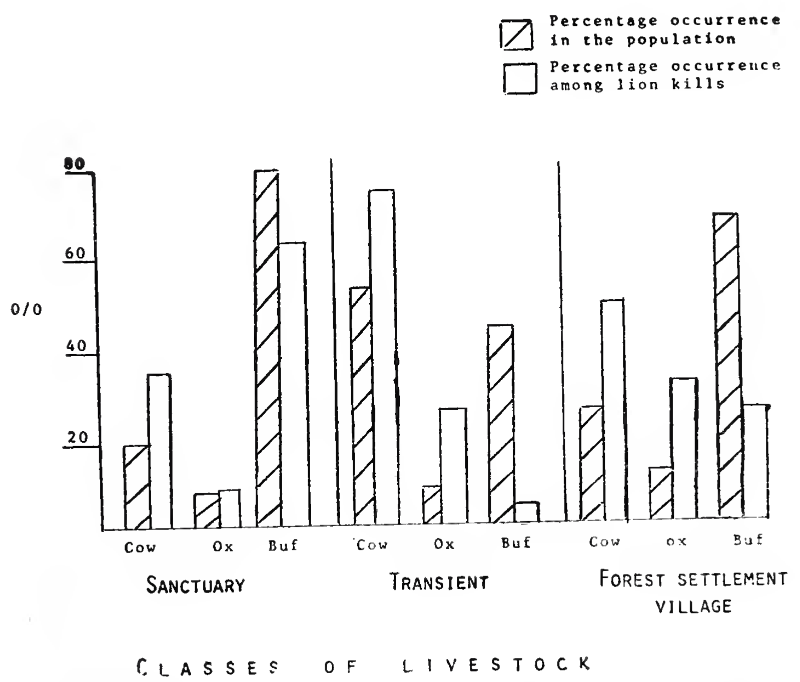

Fig. 3. Lion selection of prey from three classes of livestock.

such a result three times due to chance was less than 0.02. Averaging the results for the three village situations, twice as many cows and oxen were killed as would have been expected if they were killed directly in proportion to availability, while the proportion of buffalo kills was less than half that expected.

There was evidence that cow and oxen were more available than buffalo. First, their placement within the herd was at greater risk to predation. Miss Dorothy Brewster (pers. comm.) collected data on the position of cow, buffalo and herdsmen within herds. In a total of 27 observations she found that adult cows predominantly occupied the front of the herd in 61 per cent, buffalo occupied the middle and rear in 81 per cent, and herdsmen occupied the middle and rear in 93 per cent. In otherwords, adult cows were located where the protective influence of herdsmen was weakest. Moreover cow and oxen herds normally fled when attacked, while buffalo herds were commonly belligerent towards lions, sometimes succeeding to drive them away before the herdsmen came to their rescue. Ninety-seven per cent of 32 herds consisting only or mostly of cows were reported to have fled when attacked while 36 per cent of 75 herds consisting only or mostly

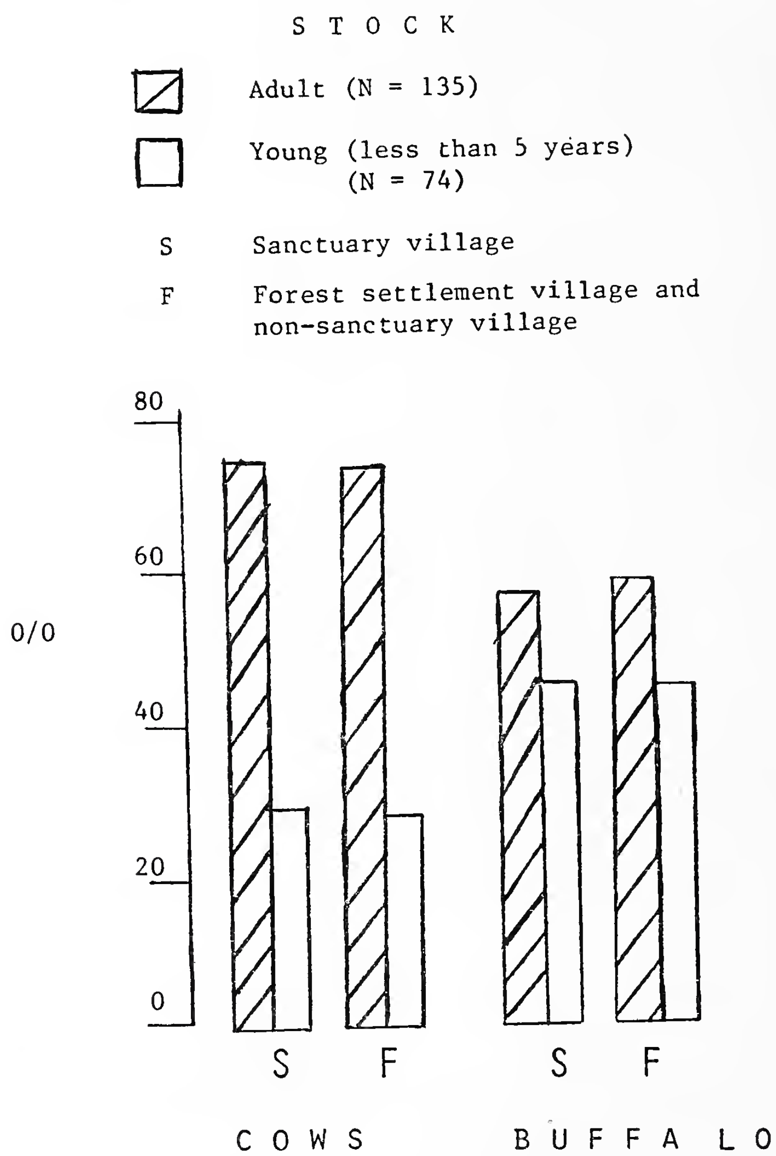

Fig. 4. Percentage occurrence of adult and young stock among lion kills from two village classes (S and F) and for two types of prey.

of buffalo behaved aggressively. Seven of 8 herds consisting only or mostly of oxen fled when under lion attack. While oxen thus appeared to exhibit little defence, these data were too few to be conclusive. However, it was further substantiated by 96 per cent of 24 herds containing mostly cows and some oxen, which fled when under attack.

Age selection : Thirty-seven per cent of 240 kills of bovid stock examined for age were young animals less than five years old. The true proportion of young animals killed was probably higher because herdsmen valued mature animals more highly, and were more likely to report their loss, despite an equal reward offered for the report of kills of any age. In sanctuary villages 41 per cent of the live bovid population and 35 per cent of kills were young stock.

More young were available inside villages than outside, and this was reflected in 20 per cent more young killed inside villages than outside (number of cases investigated = N = 240; Chi square = X^2 = 4.47; degrees of freedom = d.f. = 1; probability of occurrence = $p < 0.05$). Lions killed approximately 20 per cent more young buffalo than among cows. The same pattern emerged no matter whether the losses were from villages inside or outside the sanctuary (fig. 4). Lions killed approximately 40 per cent more young among oxen than among buffalo ($N = 126$; $X^2 = 6.44$; d.f. = 1; $p<0.05$), excluding those cases where oxen had been left alone overnight outside villages. Under such favourable conditions lions killed all stock regardless of prey type or age. A disproportionate number of adult oxen had been left out overnight, while only an insignificant number of buffalo and cows had been left out. The selection of young oxen was largely due to their greater availability. In daytime most adult oxen were employed outside the sanctuary either as plough animals or to draw carts.

Time of attack : In the 24 hour cycle there were two peaks in the numbers of prey attacked. Twenty-three per cent of attacks occurred between 0630-1130 hours and 33 per cent between 1530-1930 (fig. 5). A number

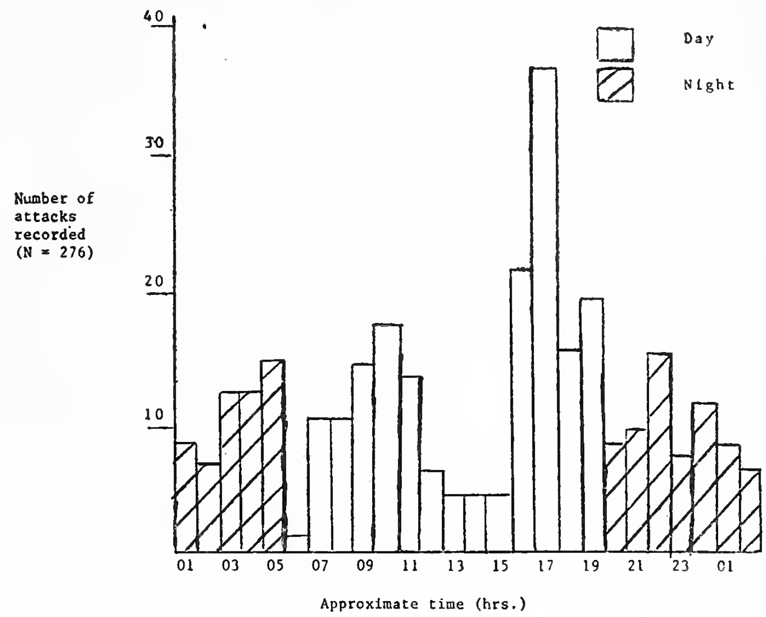

Fig. 5. Number of lion attacks upon domestic stock during each hour of the 24 hour cycle, as reported by herdsmen.

of factors accounted for these peaks. In the morning there was a build up in attacks, starting from a minimum at approximately 0600 hours and increasing to a maximum by 1000 hours. This was associated with the increase in the number of animals grazing in the sanctuary. Few attacks were made between 1130-1530 hours, when the combination of high air temperatures and direct exposure to the sun was most severe. Of those attacks which occurred between 1130-1530 hours, all but one took place either in the monsoon or early in the cool season, when daytime temperatures were moderate (less than 29°C). In the hot season most lions rested in shade through the middle of the day. The herdsmen also contributed to the lack of contact between predator and prey by

resting their stock for approximately 2 hours during that time.

Between 1530-1730 hours there was a dramatic build up in numbers of attacks, followed by an appreciable decline over the next 3 hours. At the same time the pattern of activities which paralled the morning's peak were repeated in reverse. Lions stopped resting and livestock again grazed, then returned to their village or origin, which in many cases was outside the sanctuary.

Fifteen per cent more animals were attacked in the shorter afternoon peak than in the morning, the possible reasons for which were varied. Lions also consumed more of what they killed in afternoons because of less competition with hide collectors. Stock were taken to graze in the morning only after daylight, while some stock did not return until dusk, when reduced visibility made the animals more vulnerable to attack. Stragglers were more apparent in herds by mid afternoon than in the morning, and perhaps were not given all the due care and attention by the herdsmen who were tired and anxious to return home. It was also apparent that herdsmen allowed their stock less time to graze in the afternoon, and instead kept them moving. This both increased the likelihood of a lion encounter and made conditions more unfavourable for stragglers attempting to keep up.

Only 39 per cent of attacks were made at night (approximately 1930-0530 hours). These included 11 night attacks not recorded in figure 5 because the herdsmen did not know at what hour the attack occurred. Lions were much more active at night. However, their domestic prey, which had moved about the sanctuary in daytime, was confined to village corrals at night. Only by entering the periphery of villages was it possible for lions to make an attack at night. Secondly, before any animals could be attacked, lions had to penetrate either thorn scrub fencing or rock walls which had been used as corral material specifically to prevent predation. An thirdly, much of the stock which had grazed within the sanctuary in the daytime was unavailable at night because it had been taken to villages outside the sanctuary.

Within villages the fewest night attacks occurred between 1930-2030 hours, presumably because herdsmen were not yet bedded down for the night. Some stock were also attacked outside villages at this time because a few herdsmen were late in returning their stock from grazing. No pattern was discernible among attacks in the remainder of the night. However this may have been because herdsmen were unable to estimate the time of attacks at night with much accuracy unless they occurred early.

Food consumption: Although 74 per cent of kills were reported to have involved more than one lion, the meat available was poorly utilized. In a sample of 173 kills, lions ate nothing from 24 per cent and 1-10 kg from approximately 22 per cent (table 1). Lions ate less from prey killed at night. They ate nothing

TABLE 1

AMOUNTS CONSUMED BY LIONS FROM EACH KILL

Amount removed from carcass	Number of animals	Per cent	Adjusted per cent
Nothing	42	24	24
1 – 5 kg	13	8	11
6 – 10 kg	13	8	11
A large portion (approx. half)	33	19	26
Fully utilized	35	20	28
Some	37	21	—
Total	173	100	100

from 41 per cent of night kills, 19 per cent of kills made between sunrise and noon, and 2 per cent of kills made between noon and sunset. Lions ate more than 10 kg from 11 per cent of night kills, 30 per cent of morning kills, 45 per cent of afternoon kills.

At night lions obtained most of their prey from villages. Few animals killed inside villages were eaten, while most animals killed outside villages were fed upon. The pattern was similar for carcasses from which lions ate more than 10 kg. Feeding was completely prevented in villages unless the prey was dragged outside the fences before the lions were driven off. Lions were able to feed better by day when stock was out grazing, but still lost substantial amounts.

Hide collectors: Lions failed to eat much of what they killed in the day time, because they were driven off by the graziers and because hide collectors appropriated the carcasses for the hide and meat. Herdsmen reported that they attempted to drive lions away in 72 per cent of 169 lion attacks. Once driven off, lions sometimes did not return or did so only after some time had passed. In the did so after a period of absence. In the meantime the herdsmen informed hide collectors who paid them for the meat and hide. If lions were present when hide collectors arrived, they drove the lions off. Hide collectors claimed 56 per cent of 210 kills examined. They did not bother so much with calves as with adults ($N = 168$; $X^2 = 3.07$; d.f. $= 1$; $0.1 > P > 0.05$). The largest hides also represented the greatest amounts of potential lion food. Whenever hide collectors claimed lion kills outside villages, lions fed from fewer livestock and ate lesser amounts. Lions were more successful in feeding from afternoon kills because hide collectors were sometimes informed too late to claim the carcasses before dark.

Lions utilized 25 per cent more kills inside the sanctuary than outside ($N = 177$; $X^2 = 7.82$; d.f. $= 1$; $P < 0.01$), probably because hide collectors claimed about 25 per cent fewer kills inside than outside ($N = 210$; $X^2 = 7.36$; d.f. $= 1$; $P < 0.01$). Hide collectors lived in only 5 per cent of the villages within the sanctuary. By contrast all 36 villages surveyed among 70 possible villages within 2 km of the sanctuary edge were inhabited by hide collectors. More carcasses were claimed inside the sanctuary than would be expected from the distribution of hide collectors because collectors came into the sanctuary from outside, mainly to claim cattle belonging to their villages. During the village to village census of the population of hide collectors each hide collecting family was asked to show their most recently collected skin and asked the cause of death. The skin was examined for evidence of tooth impressions and claw marks. In a total of 100 such hides examined, 20 to 25 per cent I classified as lion kills. In otherwords lion kills were representing quite a sizeable part of the hide collector's livelihood. Any program that recommended preventing them from approaching lion kills would have to take this account.

Hide collectors did not take the meat if the distance to carry it was too great, or they already had meat at home. However when meat was left it was usually taken by vultures, predominately white backed vultures *(Gyps benghalensis)*, and only rarely by lions. Hide collectors attracted vultures by pulling carcasses into the open. Skinned carcasses were easily eaten by vultures. It took only 13-30 minutes to consume three adult bovids. In contrast less than 3 kg was consumed by

vultures from two intact adult bovids after 30 minutes of intense activity. Vultures were able to penetrate the hide only at the anus, mouth, nostrils, eyes and ears. Even after the abdominal cavity of a third carcass had been penetrated, they consumed less than 20 kg in 3 hours. These marked differences in the rates by which vultures were able to consume skinned and unskinned carcasses was corroborated by Dr. Robert Grubh (pers. comm.).

Compensation : Payments were made by the Gujarat government to herdsmen whose bovid stock had been killed by lions. Its purpose was to discourage the herdsmen from poisoning lions in retaliation, and so maintain the system of lions preying on domestic stock with the minimum of hardship to the herdsmen. The number of reported cases of poisoning averaged about one per year, as pointed out earlier in this paper; presumably of minor importance to the lion population as a whole. Whether such a low level was attributable to compensation payments was questionable. When I asked herdsmen who lost stock whether they intended to request assistance, only 49 per cent replied in the affirmative. In many cases the herdsmen only had to walk 100 m from my office to the government office in order to make notification. They could have been paid compensation of Rs. 100-250 for each animal, while I only offered Rs. 10 for the opportunity of seeing their loss, independent of the number of animals involved. Probably fewer than 49 per cent of the people whom I did not interview applied for compensation, because my sample consisted of herdsmen who had shown initiative in the first place.

Many complained about the compensation system. Few understood the conditions for eligibility, all had to wait months for payment, and when it was not forthcoming they were rarely told why. The sanctuary superintendent kindly made available the application records between April 1969 and January 1971. In that time 430 applications were received, and 25 per cent rejected. Compensation was not given to those;

a) whose stock was killed more than two furlongs (approximately 400 m) from their village;
b) who possessed more than 20 head of stock;
c) who lived outside the sanctuary, but grazed their stock more than two furlongs inside the sanctuary;
d) who lost camels, goats, horses and other non-bovids.

Sixty-two per cent of 252 lion kills which I examined were further than two furlongs from the village of origin. Ignorant of the importance of distance, 45 per cent of herdsmen who lost stock beyond two furlongs said they were intending to apply for compensation. Similarly in 35 per cent of 150 cases herdsmen possessed more than 20 animals. None knew that they were not eligible for compensation. These results show that the compensation system was of limited practical benefit to herdsmen.

The effect of Food Limitations on the Lion Population

Considering first the adult male lions, they were far more active than their female counterparts, moving about twice as often, and averaging more than double the distance travelled per move. Males usually travelled either singly or in pairs, and attempted to keep out all other mature males. As far as food procurement went, when they killed an animal and the herdsmen drove them off, they simply moved on and killed again some place else. They

also appropriated kills made by lionesses whenever they came across any. Although there were far fewer adult males in the population then there were adult lionesses, I believe they regulated their numbers by driving males out of the area. They especially persecuted sub-adult males nearing maturity, which if driven out of the pride before they were old enough would starve for lack of success in food procurement. I rarely saw sub-adult males over two years of age.

Lionesses in contrast were more sedentary because of having to raise cubs. They had to procure more food than males in order to maintain both themselves and the cubs. Additionally whenever a lioness with cubs killed an animal and was driven off by a farmer, she usually had to kill locally because a lioness's method of feeding solid food to cubs is to bring them to the kill site, greatly limiting the size of area over which she can hunt. By having to fetch cubs, lionesses also gave hide collectors more time to get to the carcasses before being extensively damaged. In short, in contrast to the males, food procurement for lionesses was difficult. The ones who suffered were the cubs.

Of 45 lions seen in the field which were less than 18 months old, 29 were between 1-6 months, 11 between 7-12 months and 5 between 13-18 months. Assuming that the sample representative of the population, and these figures are a reflection of mortality rates, then 53 per cent of cub mortality occurred between 1-6 months and 7-12 months, and another 17 per cent between 7-12 months and 13-18 months. These results agreed reasonably well with observed losses. Ten out of 17 cubs first seen between 1-3 months were missing and presumed dead within 12 months after birth. (These results do not include mortality at birth for which there are no data.) In contrast, in three years only one adult lioness was known to have died in my study group of 16 adults.

Population Trend

Although the lions have dramatically declined outside the sanctuary. I do not know, apart from there being a very high cub mortality, what effect the serious food limitations are having on the lion population within the sanctuary's boundaries, because little reliable data existed on which to determine the population trend. However, in lieu of the magnitude of the food limitations, it is reasonable to err on the side of conservation, and assume that the impact on the lion population is significant.

Ever since the first estimate of the lion population size was made in 1936, investigators have attempted to make trend determinations by comparing new estimates of the population size with the old. However absolute numbers are very difficult to measure. Moreover all but one of the counts has been based on one method — lion recognition on the basis of track size — which in itself makes comparisons between counts suspect unless differences are exceedingly gross, such as the three fold reduction in lion numbers outside the sanctuary boundary in recent years.

However assessing the trend by no means needs to be dependent on any knowledge about actual population size. For example, changes over time in the number of lion tracks and scats found along roads, or changes in the number of cattle killed by lions in villages are alternative, easier ways to determine change in the lion population size.

In 1971 I estimated data on lion tracks, scats and kills as a base against which future

changes could be assessed. Considerable effort was made to simplify and streamline the means of gathering data in a standardised manner that could be easily repeated.

Track recognition : Before assessing the density of lion tracks, it was necessary to develop a method for differentiating lion tracks from leopard, the only other species with which it can be easily confused. Separation of lion from leopard tracks was done on the basis of size. Firstly each of nine sets of tracks of known leopard origin never exceeded

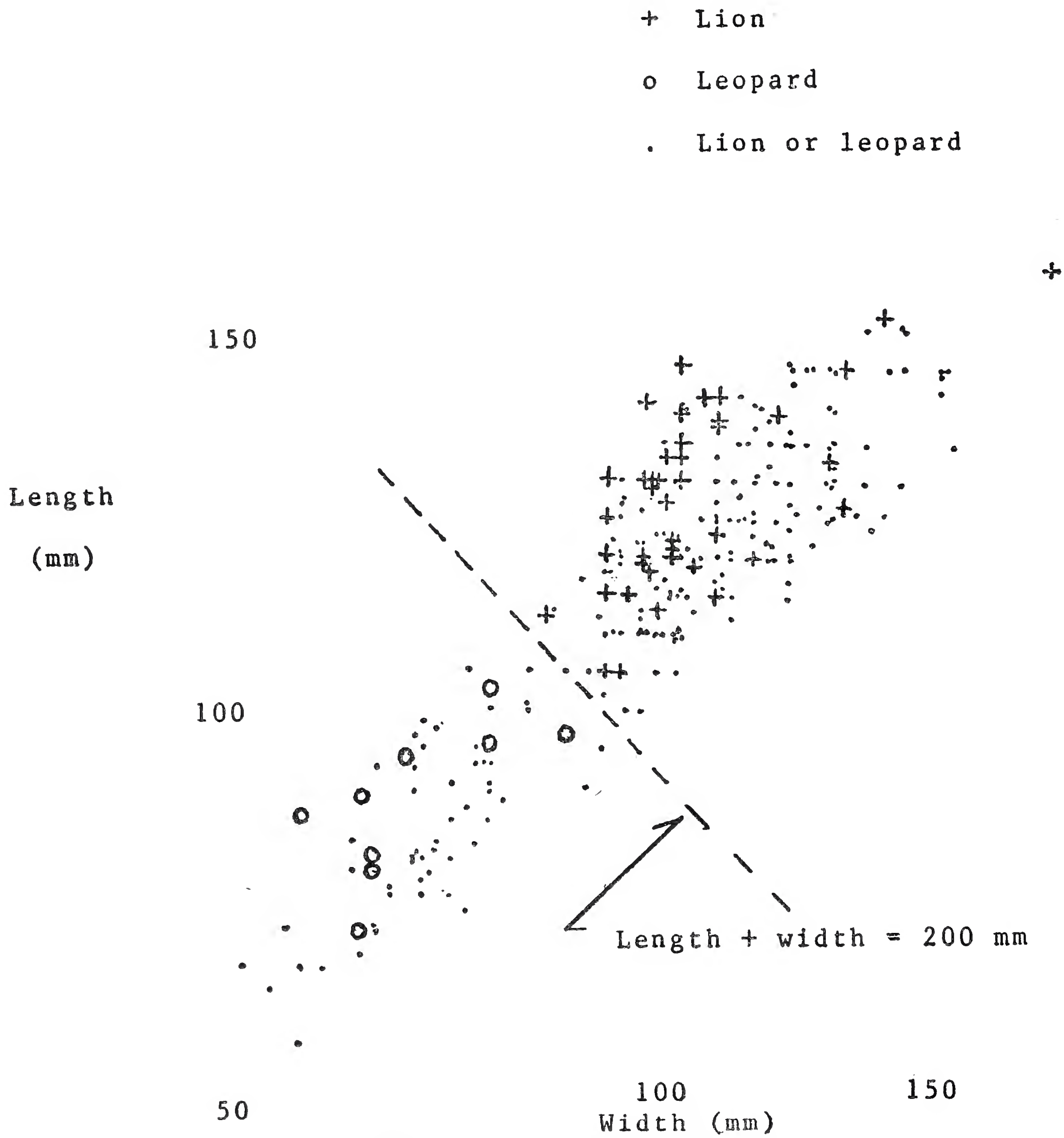

Fig. 6. Dimensions of lion and leopard tracks.

200 mm when length and width were added, while 41 sets of tracks of known lion origin exceeded this minimum. Secondly 212 recorded tracks of either lion or leopard origin indicated a bimodal distribution which separated at approximately these limits (fig. 6). Almost all of the tracks falling within the leopard size range were of solitary animals, while those falling within the lion size range were frequently of animals in groups, reflecting the difference in social behaviour between leopards and lions.

Assessment of track and scat numbers: In April 1970, 275 km of road crossing all major types of habitat within the sanctuary, except hilltops, were surveyed for scats and tracks. The survey was repeated in February 1971, covering most of the routes which had been searched the previous year. It was designed so as to make the minimum use of labour in finding sign while restricting track and scat identification to myself. Each morning at dawn I stationed 4-6 men at 4-8 km intervals along a route to be surveyed; approximately 20 km being surveyed daily. Early morning was chosen before cattle or vehicular traffic destroyed tracks. Each enumerator marked the beginning of his route and walked the distance to the start of the next beat. Scats were similarly marked. After the men had walked their beats I drove the length of the route, stopping at each location to identify tracks and scats and to record the location in kilometers when tracks were found. I assumed that all cat tracks having a length and width totalling greater than 200 mm and all scats which had a diameter greater than 4.5 cm (see 'food habits based on faecal analysis') were lion.

While both track and scat assessments were made along roads, and therefore had some of the same limitations, there were however important differences. Tracks recorded in the morning indicated only the presence of lions in the area the previous night. Scats indicated the presence of lions over several days. Miss Dorothy Brewster kindly assisted me by finding that the average time taken for scats to disintegrate or be destroyed was 6.7 days in a sample of 94 initially fresh scats inspected once daily. Another difference was that the number of scats was affected by the size of pride, whereas in the method used in assessing track density no discrimination was made between one or more lions travelling the same distance at the same time.

Seven hundred and fifty-five kilometres were travelled for track assessments; the presence or absence of tracks was recorded in units of one kilometre; 111 kilometres with tracks were recorded; on average lion tracks were found in every 7.2 km surveyed.

In order for the density of tracks to be used in determining the trend of the lion population it is essential that a constant relationship exist between the number of tracks recorded and the number of lions present. However the number of tracks which could be recorded depend on several factors. For example, the nature of the substrate determined the visibility of tracks. When the ground was soft and dusty, lions sometimes left hundreds of tracks, while on stony ground only a few were visible. The presence or absence of tracks was for this reason recorded in units of 1 km, assuming that any lion which walked some portion of this distance would leave at least one visible track.

Track density was also a function of topography and the presence or absence of alternative routes, such as buffalo trails and dried creek beds. Large, slightly raised roads appeared to be walked less by lions than smaller roads at grade level. Lions some-

times used roads to cross streams. They may often have travelled on roads in areas of teak forest to avoid a noisy walk over a forest floor of dried leaves. In addition the behaviour of lions also varied from making no use of roads on some nights to walking three or more kilometres on other nights. The biases could not be easily removed, but they could be averaged and made constant by increasing the total distance surveyed until local variations in track density had no significant effect on the average density of tracks recorded. Variations in the ratio of lion track-kilometres over kilometres surveyed leveled out after 200 km had been searched.

Five hundred and fifty-one kilometers were travelled for scat assessments, and 86 scats were collected, an average of one scat in every 6.4 km. As with lion track-kilometres, variations in the ratio of lion scats over kilometres surveyed leveled out after 200 km had been searched.

The methods used in assessing scat and track densities ignored the influence of cubs. Lions whose scats had a diameter of less than 4.5 cm and whose track total length and width was less than 20 cm were not recorded. In the case of scats it was my impression that this eliminated most cubs below one year old. Young cubs were usually kept in hiding, so their tracks and scats were rarely seen along roads. When not in hiding, cubs usually travelled in the company of lionesses and so were not detected because the method of assessing track densities did not take group size into account. Failure to record evidence of cubs means that the data can only be used to determine the trend of the adult lion population. This limitation may be highly desirable from the standpoint of management, if the stability of the lion population in the long term is more dependent upon the stability of the adult population.

Assessment of lion kills : One method was to ask herdsmen the number of days or weeks since their last animal was killed. In this method herdsmen had to recall both the event and the day. Because herdsmen find it difficult to remember dates, I used another, more laborious method. Each herdsmen was visited twice. The first time each herdsman was asked to participate in a scheme to record his losses, and given a certificate to reinforce the occasion of our meeting. Within approximately 10-15 days each herdsmen was visited a second time, and his losses recorded for the intervening period. Because the time interval was known, the herdsmen was only required to remember whether an animal had been killed and not when. The time between visits was short to ensure that the event was fresh in the herdsmen's mind, and could be confirmed. Data on the rate of killing was collected in February-March 1971 in all six districts within the sanctuary, involving a sample of 49 villages. Every herdsman in each village was interviewed.

Twenty-seven kills were recorded in 652 days assessed, an average killing rate of 0.55 animals per village, or an estimated 15.1 animals per village per year. The average killing rate per village in the time interval between visits leveled out after 30 villages had been visited. The average number of days between kills was 24, and this figure became more or less constant after data for 400 days had been assessed.

Recommendations

Outside the sanctuary nothing is being done about the expansion of cultivation, nor should there be, although there can be little doubt

that this has been the major cause for the lion's decline. Food for people is far more important than food for lions, particularly in light of present severe shortage.

Within the sanctuary cultivation is of some concern, for although it occupies less than 6 per cent of the area, much of it is illegal and rapidly expanding. Most cultivated lands encroaching upon the boundary are associated with forest settlement villages, which have themselves developed largely since the turn of the century. It is strongly recommended that further expansion be curbed.

In 1972 the government of Gujarat sanctioned the construction of a wall around parts of the sanctuary which should greatly assist the forest department in combating illegal encroachment by cultivators, as well as curb the influx of cattle. Also sanctioned was a proposal to relocate to the outside of the sanctuary the majority of the indigenous cattle graziers along with their stock. Both of these actions should help a great deal in bringing the impact of cattle grazing within the sanctuary more in line with the carrying capacity of the land, removing the long term problems of overgrazing. While the Gujarat government is to be commended on its plan, the effects of even a limited reduction in domestic stock numbers on the lion population should be carefully studied, because of the lion's high dependence on domestic stock for its own survival. The earliest descriptions of Gir refer to cattle being there in large numbers, which makes it even more imperative that the reduction be very carefully monitored as to its impact on the lion.

The food chain is further complicated by the large amount of food stuffs imported into the sanctuary each year. Herdsmen interviewed in 50 villages reported feeding a daily average of 3.8 kg of cotton seed and ground nut to each adult buffalo and smaller amounts to cow and oxen, or an estimated 19 million kg fed to all domestic bovids within the sanctuary each year.

As a result of having demonstrated that hide collectors claim over half of the lion's kills, steps have been taken to make this activity illegal. However, although this will most assuredly make more food available to lions, I am concerned for the welfare of the hide collectors. Lion kills represent 20-25 per cent of the skins taken by hide collectors, representing quite a sizeable part of the hide collector's carcass claiming livelihood. Moreover these people belong to the lowest social strata, and do not do their unprofitable work by choice. There have been a number of good and successful schemes elsewhere in the country to resettle such people as cultivators, giving them a chance to succeed according to their own abilities. Would it not be better to give the hide collectors of the Gir a chance to cultivate outside the sanctuary, as some have asked, and in this way benefit not only the lion but the people as well?

Hide collectors are not the only reason why lions are required to kill far more than they need to get enough to eat. Feeding was poorest at night, when lions made kills within villages and were driven off by villagers before they had fed. They ate nothing from 41 per cent of domestic animals killed at night. Much of this loss of food would be reduced, and fewer stock lost as a result, if herdsmen made kills available to lions by moving carcasses to the outside of villages immediately following an attack. The means by which this could be made operative is by making it one of the conditions for compensation. At present farmers are paid amounts ranging from 100 to 300 rupees whenever a lion kills one of their stock. However the system

of payment would have to be greatly improved before it could be used to ensure that the lion ate what it killed. Of the herdsmen to whom I paid a mere ten rupees in order to see their loss, less than 50 per cent said they intended to apply for government compensation, and fewer actually did. Of the estimated several thousand livestock killed between 1969 and 1971, only 430 applications for payment were made of which 25 per cent were rejected. Few herdsmen understood the conditions for eligibility, all had to wait months for payment, and when it was not forthcoming they were rarely told why.

While preservation of the lion is easily justifiable on the grounds that it is a significant part of India's wildlife heritage, it is difficult to financially justify it when the resources of the country are so limited. The future of the lion in the long run perhaps ought to include more schemes which can make it a better resource capable of paying its own way. For instance, only a few thousand tourists visit the Gir annually, while the cost to the government in providing just the tourist facilities is twice that which the tourist revenue contributes. The Gir Wildlife Sanctuary would benefit from greater promotion, especially outside the country where the lion's existence is little known, let alone knowledge that within a few hours after leaving Bombay visitors can both see lions in their natural habitat and approach them on foot.

At present the majority of tourists who do come do not stay overnight because after seeing the lions there is little else for them to do. Improvement in the habitat of the Gir through a gradual reduction in the number of cattle should result in substantial increases in the populations of many native wildlife species, all of which should benefit the development of a more varied program of wildlife related activities which visitors could participate in.

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NEW DESCRIPTIONS

A NEW SPECIES OF THE GENUS *OXYURELLA* DYBOWSKI AND GROCHOWSKI, 1894, (CLADOCERA: CHYDORIDAE) FROM INDIA[1]

PRAMOD D. RANE[2]

(*With six text-figures*)

The genus *Oxyurella* was described by Dybowski and Grochowski in 1894 with *Oxyurella tenuicaudis* (Sar, 1862) as the type species. This genus is not so well known from India as only one species *O. singalensis* (Daday, 1898) was previously reported from South India. While examining the cladoceran collection from Madhya Pradesh I examined several female specimens which appeared similar to *O. singalensis,* but critical examination of the male, showed that the specimens belonged to a hitherto undescribed species.

Oxyurella sangramsagari sp. nov.

MALE.

Body oval. Postero-ventral corner of valves rounded without denticles but row of spinules on the inner side. Rostrum blunt. Valves without lines. Antennules not reaching apex of rostrum. Esthetascs of different lengths, projecting beyond apex of rostrum. Antennules with a two-segmented sensory papilla present on lateral side near the apex. Plate of labrum rounded with a slight concavity to the upperside. Post-abdomen narrowing distally with one large hook-shaped and one small anal denticles; 5 to 6 groups of lateral setae in the middle of post-abdomen. There is a distinct incision at the base of claw. Claw slightly bent at its distal end with two basal spines; distal larger, about slightly less that $\frac{1}{2}$ length of the claw and situated at about $\frac{1}{4}$ of the total length of claw from base. Ventral side of valve with setae along its entire margin. First leg with two chitinized hooks on the base of outer ramus of endite which serves for attachment of the valve of female. Hooks with large bunch of setae at the base.

FEMALE.

Female is larger than male, without lines on the valves. Ventral margin of valve with setae along its entire margin, Antennules not reaching apex of rostrum. Plate of labrum rounded. Rostrum with blunt apex. Post-abdomen slightly narrowing distally, with 13 anal denticles decreasing in size proximally; distal denticle longest and a small curved denticle before it. Claw with three basal spines, proximal two smaller and distal one larger, about slightly less than $\frac{1}{2}$ length of the claw. Group of lateral setae present on the post-abdomen.

Measurements: Length of male 0.52 mm., length of female 0.6 mm.

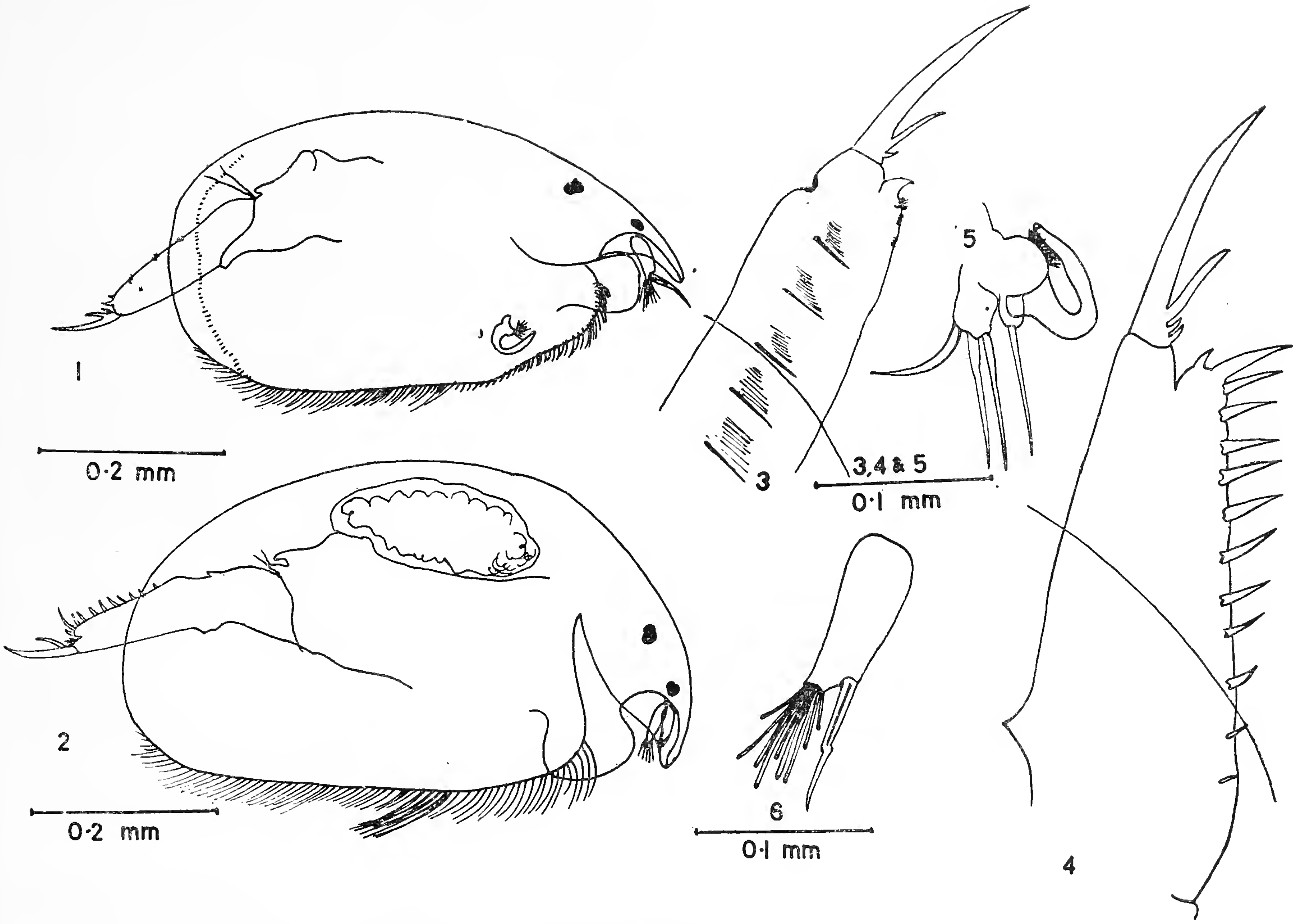
[1] Accepted March 1983.

[2] Zoological Survey of India, Central Regional Station, Jabalpur, 482 002.

TABLE 1

SHOWING DISTINGUISHING CHARACTERS OF THE SPECIES OF THE GENUS *Oxyurella*

Oxyurella sangramsagari sp. nov.	*Oxyurella singalensis* (Daday)	*Oxyurella tenuicaudis* (Sars)	*Oxyurella longicaudis* (Birge)
	MALES		
Antennule:			
Not reaching apex of the rostrum and with one large, two segmented sensory papilla which almost coming out of the rostrum.	Reaching apex of the rostrum and without any sensory papilla.	Not reaching apex of the rostrum and anterior margin with a flagellum distally.	Not reaching apex of the rostrum and without sensory papilla laterally.
Post-abdomen:			
One large hook shaped anal denticle at rounded margin.	Three anal denticles.	No anal denticle.	No anal denticle.
Claw:			
Two basal spines, distal spine is large about three times larger than proximal one.	Two small basal spines of equal length.	S—shaped with one basal spine.	One basal spine.
	FEMALES		
Plate of Labrum:			
Rounded.	With slightly pointed apex.	Broadly rounded.	With pointed apex.
Antennule:			
Not reaching apex of the rostrum.	Almost reaching apex of the rostrum.	Not reaching apex of the rostrum.	Not reaching apex of the rostrum.
Claw:			
Three basal spines.	Four basal spines.	A long basal spine.	One basal spine.
Post-abdomen:			
With out groups of lateral setae.	Present.	Present.	Present.
Claw setation:			
Fine setation at distal end of claw absent.	Present.	Absent.	Setae present proximal to the spine.



Figs. 1-6. *Oxyurella sangramsagari* sp. nov.
1. Lateral view of male; 2. Lateral view of female; 3. Postabdomen of male showing hook shaped anal spine; 4. Postabdomen of female; 5. Chitinized hook in 1st leg of male; 6. Antennule of male with 2 segmented lateral papilla.

Type specimens: Holotype male, paratypes fifteen males, allotypes forty five females, deposited in National Collection of Zoological Survey of India, Calcutta. [C 3117/2, C 3118/2, C 3119/2]

Type-locality: Sangramsagar tank behind Medical College, Jabalpur, Madhya Pradesh. Coll.: P. D. Rane, 1-xii-1978.

Discussion: Table 1 shows the characters on the basis of which *Oxyurella sangramsagari* sp. nov. can be distinguished from its three closely related species.

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A NEW SPECIES OF THE GENUS *BOSMINOPSIS* RICHARD, 1895 (CRUSTACEA: CLADOCERA: BOSMINIDAE) FROM INDIA[1]

PRAMOD RANE[2]

(*With three text-figures*)

The Cladocera of family Bosminidae are little known from India, and the genus *Bosminopsis* has not been reported from the Indian sub-continent. While studying the Cladoceran fauna of Madhya Pradesh, I came across a new species of the genus *Bosminopsis* which is described here.

Bosminopsis devendrai sp. nov.

Material: 1 ♀ (Holotype) and 3 ♀♀ (Paratypes) Location: Pariat tank on Amerkantak road, Jabalpur district, Madhya Pradesh, India, Coll.: P. D. Rane.

Date of collection: 27 August 1977.

The types are on slides and are in the National Zoological Collection, Zoological Survey of India. (Holotype No. C 3115/2 and Paratype No. C 3116/2).

DESCRIPTION

Body hyaline, valves thin, reticulate with polygonal cells. Infero-postal angle with large spine which is in between two rather small spines, ventro-posterior side of the valve with 4-6 denticles. Basal part of the antennules united with each other and with head to form sinuate posterior margin. One large spine near apex with several olfactory setae. Antenna with three jointed rami. Post-abdomen with sinuate posterior margin. One large spine near claws, more than half the length of post-abdominal claw. The anterior lobe of the post-abdomen with about four, and posterior with about 7, minute spinules. Eye usually large, situated dorsally. Postero-dorsal corner of valve slightly protrudes out. Intestine not coiled, anus terminal. Male unknown. Length of female: 0.28-0.33 mm.

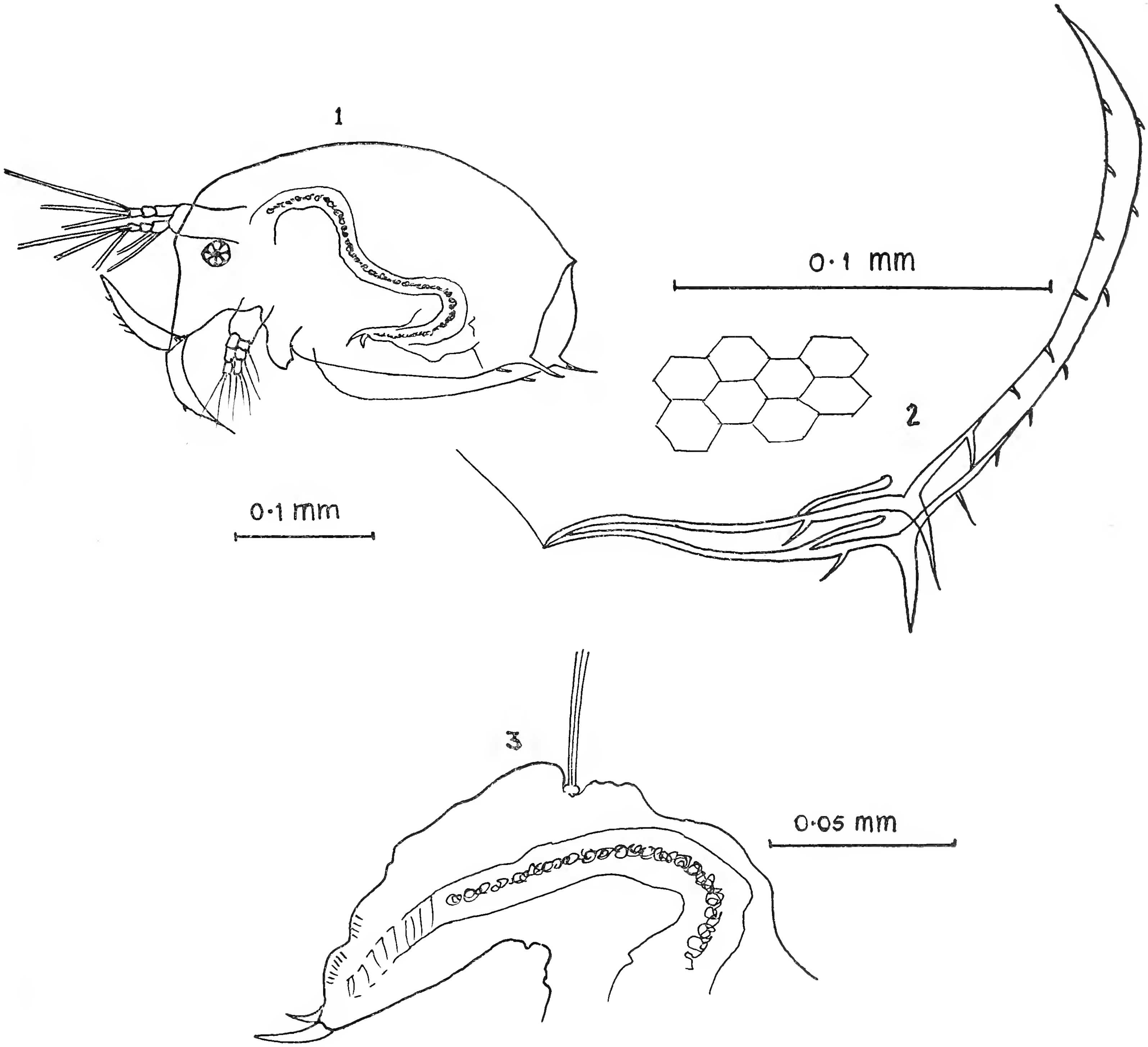
AFFINITIES

The new species *Bosminopsis devendrai* appears to be similar to the only species known under the genus namely, *B. deitersi* Richard, 1895; but can be separated from it as follows:-

1. Post-abdomen of *Bosminopsis deitersi* Richard tapering to point at claws, while in *B. devendrai* it is sinuate.
2. Postero-dorsal corner of valve somewhat protruding out in *Bosminopsis devendrai*, while it does not protrude out in the other species.
3. The large spine on infero-lateral angle is in between two rather small spines in *Bosminopsis devendrai*, while in *B. deitersi* only one small spine is present at the proximal side of the large spine. The large spine is comparatively larger in *B. devendrai* than in *B. deitersi*. In addition to the above mentioned differences, the ventral margin of valve with 4-6 small spines is a unique character for the new species.

[1] Accepted June 1983.

[2] Zoological Survey of India, Central Regional Station, Jabalpur, Madhya Pradesh, 482 002.



Figs. 1-3. *Bosminopsis devendrai* sp. nov.
1. Parthenogenetic female; 2. Infero-postal angle of valve showing large spine between two rather small spines and six denticles; 3. Post-abdomen.

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A NEW SPECIES OF THE GENUS *MIXOCERA* WARREN (SUBFAMILY: GEOMETRINAE)[1]

V. K. Walia and H. R. Pajni[2]

(*With seven text-figures*)

The genus *Mixocera* Warren is so far represented by a single Indian species namely *parvulata* (Walker) (Prout 1913). Out of a total of 99 species of the family Geometridae studied by us, one new species falls under genus *Mixocera* Warren. The present communication includes the complete description of *Mixocera albilineata* sp. nov., a revised characterization of genus *Mixocera* Warren and a key to the 2 Indian species of this genus.

Genus MIXOCERA Warren

Mixocera Warren, 1910, Nov. Zool., *8*: 206; Prout, 1912, Gen. Ins., *129*: 1934, Seitz Macrolep., *12*: 133.

Gynandria Turner, 1910, Proc. Linn. Soc. N. S. Wales, *35*: 575; Gen. Ins., *129*: 243 (subgen.)

Thelycera Prout, 1912, Gen. Ins., *129*: 243 (subgen.)

Frons smooth. Antenna weakly bipectinate to nearly simple or ciliated, varying in both sexes. Labial palpus in both sexes short; second segment shortly rough scaled; third segment minute. Proboscis weak. Hind tibia in both sexes with only terminal spurs. Abdomen not crested. Fore wing with costa slightly arched or even nearly straight; apex acutely angulate; termen smooth, oblique or gently curved. Discal cell about half of wing length; DC_2 more or less curved. R_1 from near apex of cell or from base of stalk of R_2, R_3, R_4, R_5 and M_1 or anastomosing with or running into Sc; R_2 arising from before R_5; Cu_1 from before or angle or shortly stalked with M_3. Frenulum absent in both sexes. Hind wing with apex rounded; termen moderately to rather strongly rounded; Discal cell less than one-half; discocellulars oblique, at least posteriorly. Sc + R_1 shortly appressed to or anastomosing with cell near base, then diverging; Rs and M_1 stalked; M_3 and Cu_1 shortly stalked, occasionally both veins from lower angle of cell. Uncus beak-shaped; socii slender; gnathos ring-like; coremata present. Valva long; sacculus produced into a pointed finger-like structure; aedeagus broad in posterior two-third length.

Type-species: *Mixocera parvulata* (Walker)

The only Indian species namely *parvulata* (Walker) under the present genus (Prout 1913) could not be collected for study but a new species from a different locality is described.

Key to the species of *Mixocera* Warren

Thorax and abdomen bluish green; fore wing with a curved antemedial and obliquely straight postmedial white line; underside green, with prominent postmedial band ....*albilineata* sp. nov.

Thorax and abdomen white; forewing having only an oblique postmedial white band; underside white, unmarked............*parvulata* (Walker)

Mixocera albilineata sp. nov. (Figs. 1-7)

MALE. Head with vertex covered with white scales; frons yellowish brown. Antenna serrate and fasciculate, cilia long; flagellum slightly longer than half the length of forewing. Eyes black, with a row of white scales behind. Labial

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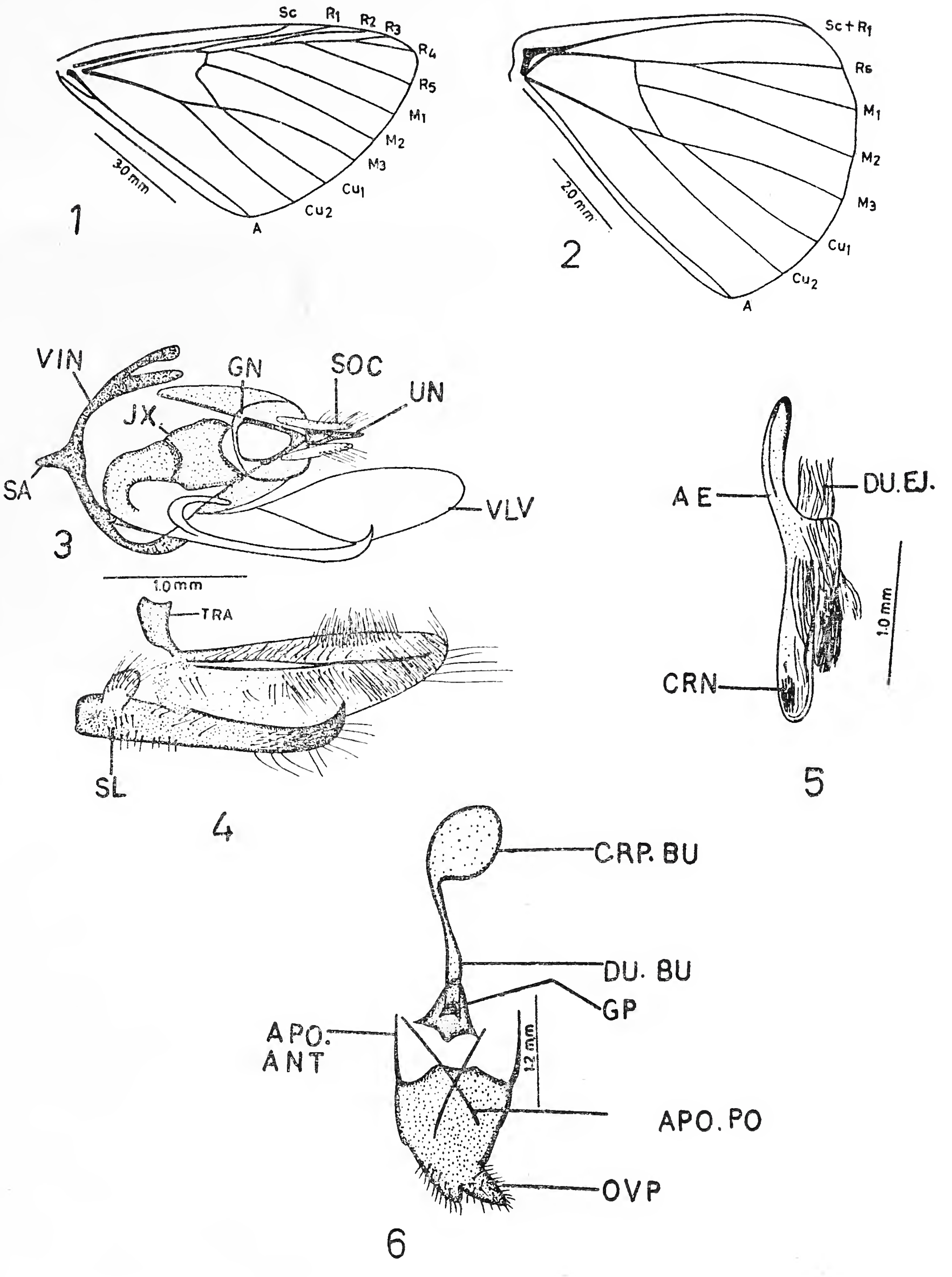

Figs. 1-6. *Mixocera albilineata* sp. nov.

Figs. 1,2. Fore and Hind wings; 3,4,5. Male genitalia; 6. Female genitalia. *Abbreviations*: 2A, Second anal vein; AE, Aedeagus; APO. ANT., Anterior apophyses; APO. PO, Posterior apophyses; CRN, Cornutus/cornuti; CRP. BU, Corpus bursae; Cu_1, First cubitus; Cu_2, Second cubitus; DU. BU, Ductus bursae; GN, Gnathos; JX, Juxta; M_1, First medius; M_2, Second medius; M_3, Third medius; OVP, Ovipositor; R_1, First radial; R_2, Second radial; R_3, Third radial; R_4, Fourth radial; R_5, Fifth radial; Rs, Radial sector; SA, Saccus; Sc, Subcosta; Sc + R_1, Stalk of Sc and R_1; SL, Sacculus; SOC, Socii; TRA, Transtilla; UN, Uncus; VIN, Vinculum; VLV, Valva.

palpus with first and second segments pale ochraceous, sparingly suffused with brown; third segment tipped with white scales.

Thorax bluish green dorsally, white ventrally. Forewing with termen obliquely arched. Ground colour bluish green; a curved antemedial and obliquely straight postmedial line white; marginal fringe green, with a light green band. Underside green, with a straight white postmedial band. M_3 and Cu_1 very shortly stalked from lower angle of cell. Hindwing with ground colour bluish green, with only white postmedial, slightly arched line; marginal fringe green with a light green band. Underside as described under fore wing. Rs and M_1 long stalked from upper angle of cell; M_3 and Cu_1 on a comparatively shorter stalk. Legs clothed with white appressed scales; hind tibia not dilated.

Abdomen bluish green on upperside, without dorsal tufts; underside white. Male genitalia with uncus narrowly beak-shaped and pointed distally, strongly sclerotized, completely bare; socii shorter than uncus, tubular, bearing short setae; gnathos squarish, weakly sclerotized; tegumen with V-shaped thickening; vinculum broadly U-shaped, produced into a short conical saccus. Valva long and narrow; costa with basal half bare, distal half densely setosed; sacculus well sclerotized, produced distally into an arched, shortly dentate and sharply pointed process; coremata present. Aedeagus long, with its anterior one-third part slender and bent, remaining two-third distal portion broad; vesica adorned with a bunch of long spines in addition to other sclerotized patches and lines, distal end of vesica also carrying a few short spines. Female genitalia with corpus bursae globular, membranous and marked with wrinkled channels distally; ductus bursae more or less as long as corpus bursae, very wide, well sclerotized, with its surface minutely denticulate anteriorly; genital plate rugose, moderately sclerotized; anterior apophyses straight, less than half of posterior apophyses, the latter slightly curved; ovipositor lobes furnished with numerous setae.

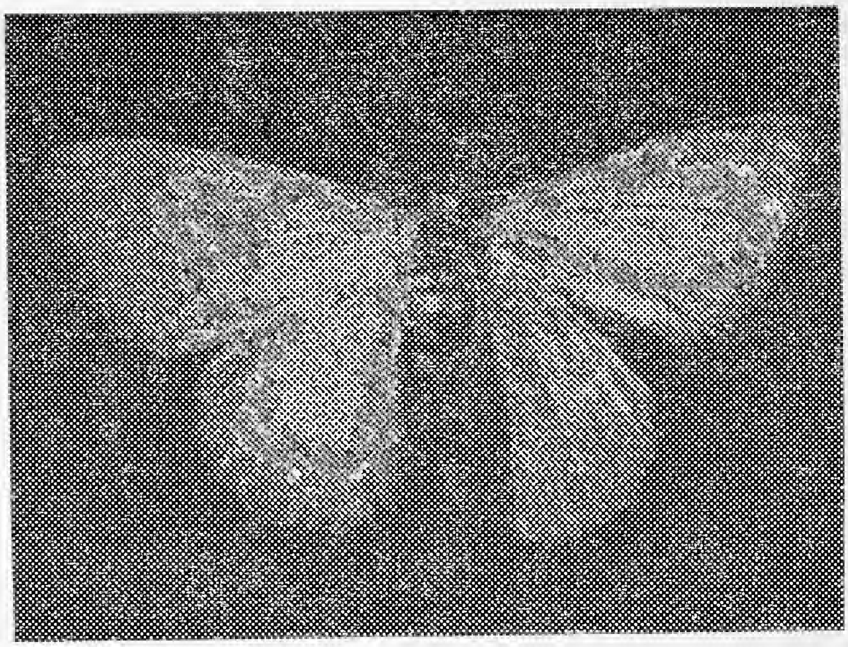

Fig. 7. *Mixocera albilineata* sp. nov.

Wing expanse (Half): Male 12 mm; Female 12 mm.

Holotype ♂, INDIA: HIMACHAL PRADESH: Chambaghat, 14.viii.1978, light, Coll. V. K. Walia. Allotype ♀, same data as for holotype. Paratypes; 7 ♂, Chambaghat, August, light, Coll. V. K. Walia. (Types in Entomology Section, Department of Zoology, Panjab University, Chandigarh).

Distribution: INDIA: Himachal Pradesh.

Apart from the much larger size, the new species differs from *parvulata* (Walker) in the coloration of the frons and the wings and in possessing fasciculate and slightly serrate antennae unlike weakly pectinate antennae of *parvulata* (Walker).

ACKNOWLEDGEMENTS

We are grateful to the University Grants Commission for financing a 3-year project on

Family Geometridae under which this work was carried out. We are also thankful to Dr. D. S. Fletcher, British Museum (Natural History), London for comparing the material. The laboratory facilities provided by the Chairman, Department of Zoology, Panjab University, Chandigarh are also gratefully acknowledged.

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FRESHWATER ALGAE OF KARNATAKA STATE (INDIA): *COSMARIUM KAYCEDENSE* SP. NOV. AND *EUGLENA LUNARIS* SP. NOV. FROM DHARWAD[1]

G. R. Hegde[2] and S. G. Bharati[3]

(*With two text-figures*)

Gandhi (1956) first reported 44 forms of diatoms from Dharwad area. Subsequently, Bharati and Gonzalves (1962) recorded some new species of Desmids from this place and an account of 49 species of Desmids was given by Bharati (1965 and 1966). In an extensive systematic survey of freshwater algae of Dharwad, collections were made from six man-made tanks in the Karnatak College Campus, Dharwad. These tanks are fed with municipal tap water and are being used for growing aquatic plants like *Hydrilla, Chara, Vallisneria, Nymphaea* and *Salvinia.* Samples collected on 25.iv.1978 by squeezing these macrophytes were preserved in 4% formaldehyde solution for further study. They are now deposited in the Phycology Laboratory, Karnatak University, Dharwad.

A detailed study of these samples from Karnatak Science College, revealed two new taxa, belonging to genera *Cosmarium* Corda and *Euglena* Ehr. They have been described in the present paper.

Cosmarium kaycedense sp. nov. (Fig. 1).

Cellulae singulares, parvae, *c.* 1½ plo longiores quam latae, ovato-ellipticae, profunde constrictae, sino lineari et ad apicem paululum dilatato; semicellulae pyramidali-truncatae ad apicem, angulis basalibus rotundato-subtriangularibus, lateribus primo parallelis deinde apicem versus divergentibus; apex 13 granula; sex circum granulum centrale, et alia in duobus ordinibus disposita, habens. Semicellula a latere visa elliptica, in centro sex incrassationes granulosas proebens.

Longitudo 36.5-55.5 μm; Latitudo 28-29 μm; Isthmus 4-7 μm; Crassitudo 20 μm.

Locus typi: In stagna contra Departmentum Zoologicum Collegii Scientifici Karnatak, Dharwad.

Cells single, small, about 1½ times as long as broad, oval elliptical, deeply constricted, sinus linear, slightly dilated at the apex; semicells pyramidate-truncate at the apex, basal angles rounded-subtriangular, sides parallel at first, then converging towards the apex which

[1] Accepted June 1983.

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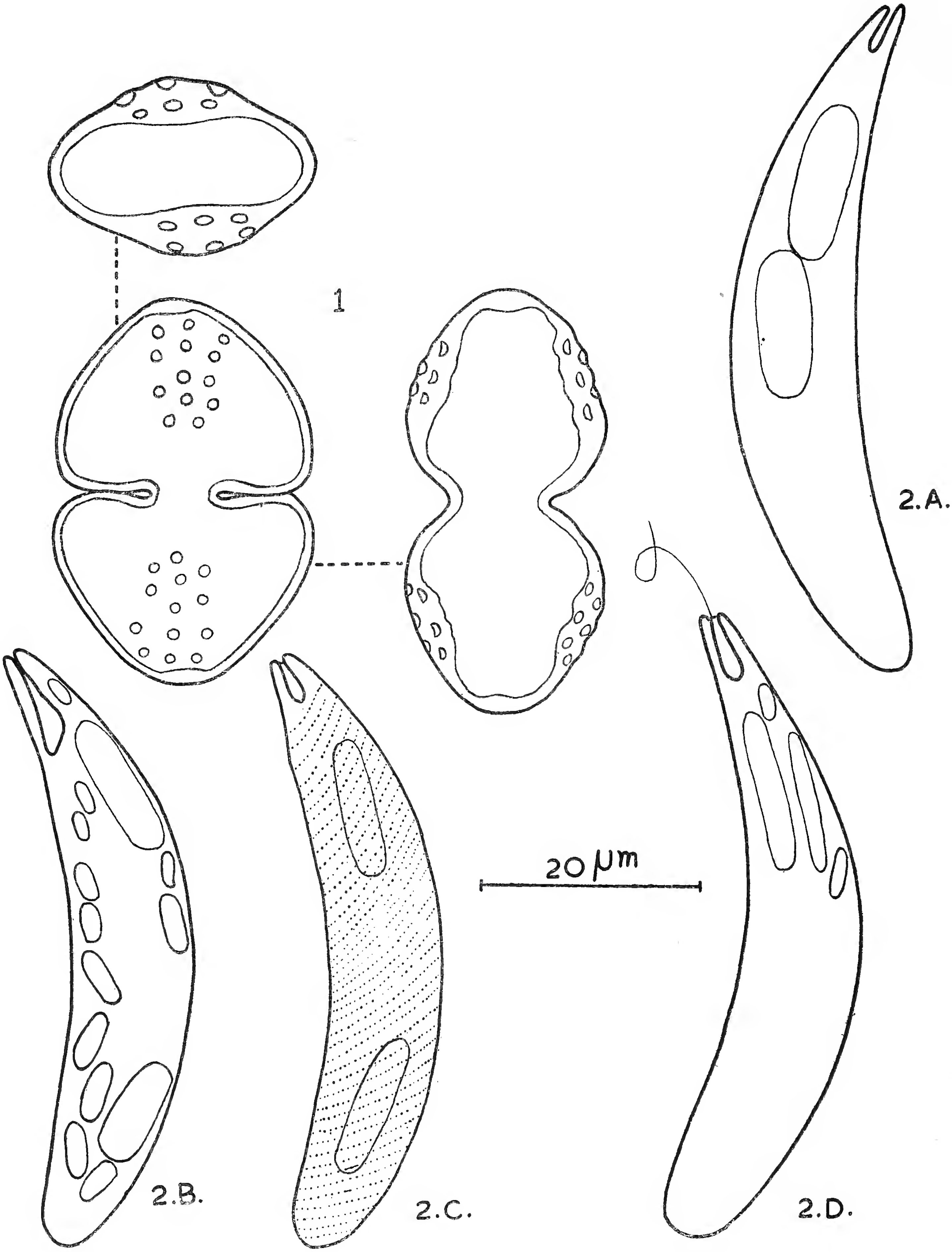

Fig. 1. *Cosmarium kaycedense* sp. nov.
Fig. 2. A-D. *Euglena lunaris* sp. nov.

has 13 granules, 6 of which are round a central granule and the others are arranged in two rows. Side view of semicell elliptical with six granular thickenings in the centre.

Length 36.5-55.5 μm; Width 28-29 μm; Isthmus 4-7 μm; Thickness 20 μm.

Locality: Planktonic in the pond opposite to Zoology Department, Karnatak Science College, Dharwad.

The new taxon resembles *C. granatum* Bréb. in shape, but differs in having thickened mid-region and the granules in lateral view. Other species which it resembles are *C. galeritum* Nordst. var. *westii* Krieger *et* Gerloff, Förster 1969, pl. 15, fig. 5, p. 50 and *C. incrassatum* (Fritsch *et* Rich) Krieger *et* Gerloff var. *brasiliense* Förster; Förster 1969, pl. 18, figs. 1 & 2, p. 51; but in view of major differences it is named as a new species.

Euglena lunaris sp. nov. (Fig. 2, A-D)

Cellulae lunatae, metabolicae, elongatae, ad extremitatem posteriorum rotundatae, ad anteriorem extremitatem attenuatae, manifeste bilabiatam et falgello brevi praeditam. Membrana tenuiterstriata. Corpora pyrenoides duorum modorum: duae lamellae discoideae magnae atque 2-12 lamellulae breves additicae.

Longitudo 55-57 μm; Latitudo media in parte 11 μm, ad os 22.5 μm; Longitudo flagelli 21-23 μm.

Locus typi: In stagno contra Departmentum Zoologicum Collegii Scientifici Karnatak, Dharwad.

Cells crescent shaped, metabolic, elongate truncately rounded at the posterior end and tapering at the anterior end, cospicuously two lipped with a short flagellum. Membrane finely striated. Paramylon bodies of two sorts, 2 big discoid plates and 2-12 additional short plates. Chloroplast numerous, discoid.

Length 55-57 μm; Width middle 11 μm; Width mouth 22.5 μm; Length of flagellum 21-23 μm.

Locality: In the pond behind Zoology Department, Karnatak Science College, Dharwad.

This flagellate does not resemble any known form and hence is considered a new species.

Acknowledgements

We are grateful to Dr. G. W. Prescott for the confirmation of new taxa and to Dr. H. Croasdale for the Latin diagnosis. Thanks are also due to Prof. M. S. Chennaveeraiah, Head of the Department of Botany, Karnatak University, Dharwad for the facilities afforded. Financial assistance by C.S.I.R., New Delhi, to one of us (G.R.H.) is gratefully acknowledged.

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A NEW SPECIES OF *IMPATIENS* L. (BALSAMINACEAE) FROM SOUTH INDIA[1]

M. CHANDRABOSE, V. CHANDRASEKARAN AND N. C. NAIR[2]

(*With eleven text-figures*)

Impatiens konalarensis sp. nov.

Impatiens elegans Bedd. affinis, sed floribus parvioribus; vexillo ovato-lanceolato; lobo terminali alae obovato vel semi-circulari; et seminibus glabris, tuberculatis differt.

Holotypus *Chandrabose* 69013 (CAL) et isotypi *Chandrabose* 69013 (MH Acc. No. 126620, 126621, 126622, 126623, 126624, 126625, 126626) lecti in collibus Konalar, Anamalai in Dist. Coimbatore, Tamil Nadu (ditione Madras), in 18-11-1980.

Impatiens konalarensis sp. nov.

Allied to *Impatiens elegans* Bedd., but differs in having flowers smaller; standard petal ovate-lanceolate; terminal lobe of wing petal obovate or semicircular; and seeds glabrous, tubercled.

Herbs 20-75 cm high, rooting at lower nodes. Leaves 1-9 × 0.7-4.5 cm, alternate, ovate or elliptic-ovate, crenate, glabrous excepting the nerves, acute or acuminate at apex; base rounded or subacute, sometimes inequilateral; lateral nerves 4-6 pairs, arcuate; petioles up to 6.5 cm long, slender, glabrous. Flowers 1.2-1.5 cm across, pink, few in contracted racemes; peduncles up to 4 cm long, axillary, slender, glabrous; pedicels ± 7 mm long, slender, glabrous; bracts ± 4.2 × 2.5 mm, ovate-lanceolate, acuminate, glabrous. Sepals 3; laterals 2, each ± 4.5 × 2.5 mm, green with pink tinge, obliquely ovate, acute or acuminate, glabrous; posterior sepal ± 8.5 × 5.5 mm, pink, ovate-elliptic, concave, acuminate, glabrous; spur absent. Petals 3, pink; standard petal ± 6.5 × 3.5 mm, ovate-lanceolate with a pointed acumen, concave, glabrous; wing petals 2, each ± 12 × 5 mm, glabrous, 2-lobed; terminal lobe ± 11 × 5 mm, obovate or semicircular, rounded at apex, auricled at base; side lobe ± 5.2 × 2.5 mm, oblong, obtuse at apex. Stamens five; filaments ± 4 mm long, free, shortly connate at apex; anthers ± 1 mm long, cohering. Ovary ± 3 × 1 mm, ovate-elliptic, acute at apex, glabrous; stigma sessile, 5-toothed. Capsules ± 9 × 4 mm, obliquely ellipsoid, beaked, glabrous; seeds ± 4.5 × 3 mm, ovoid, tubercled, glabrous.

The holotype *Chandrabose* 69013 (CAL) and isotypes *Chandrabose* 69013 (MH. Acc. No. 126620, 126621, 126622, 126623, 126624, 126625, 126626) were collected in Konalar, Anamalai in Coimbatore District, Tamil Nadu (Madras State) on 18.11.1980.

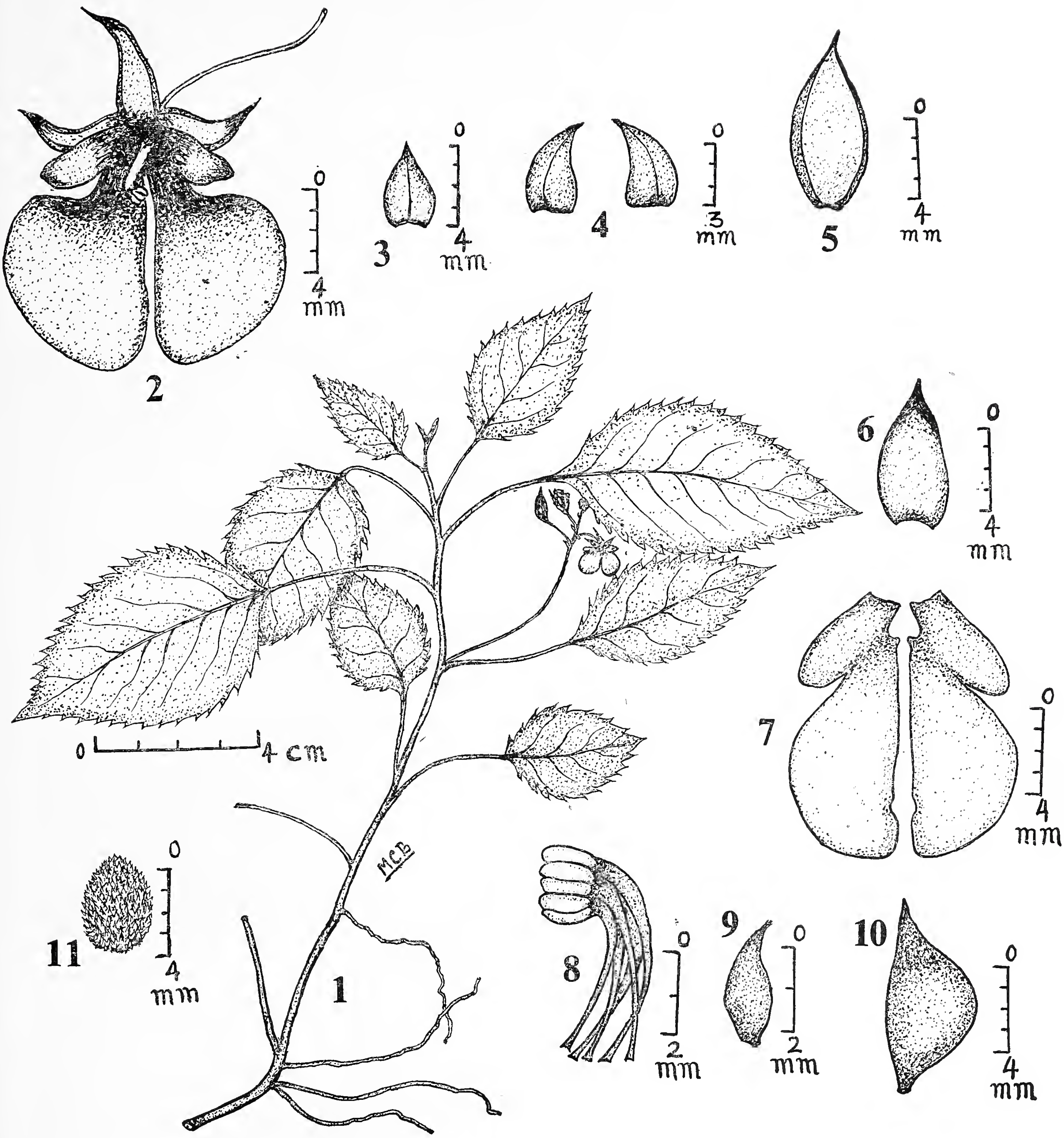
This herb grows usually in the sholas near streams at an altitude of 1950 m.

ACKNOWLEDGEMENT

Grateful thanks are due to Dr. V. J. Nair, Systematic Botanist, Botanical Survey of India, Coimbatore for rendering Latin translation.

[1] Accepted April 1984.

[2] Botanical Survey of India, Coimbatore-641 003.



Figs. 1-11. *Impatiens konalarensis* sp. nov.
1. A twig; 2. Flower; 3. Bract; 4. Lateral sepals; 5. Posterior sepal; 6. Standard petal; 7. Wing petals; 8. Androecium; 9. Gynoecium; 10. Capsule; 11. Seed.

A NEW SPECIES OF *PARASYRPOPHAGUS* GIRAULT (HYMENOPTERA: ENCYRTIDAE) FROM ALIGARH, INDIA[1]

ANIS FATMA AND S. ADAM SHAFEE[2]

(*With a text-figure*)

Parasyrpophagus aligarhensis sp. nov
(Fig. 1, A-G)

FEMALE. Head dark and smooth; frontovertex slightly wider than long; ocelli brown, arranged in obtuse triangle, lateral ocellus separated by less than its diameter from inner orbital and occipital margins separately; malar space as long as eye width; malar sutures indistinct; mandibles (fig. 1, A) tridentate; Antennae (fig. 1, B) brownish except scape yellow; scape long, six times as long as wide; pedicel slightly longer than first funicle segment; funicle segments 1-6 gradually decreasing in length distad; funicle segments first and second more than twice as long as wide, sixth one and a half times as long as wide; club 3-segmented, four and a half times as long as wide, slightly longer than preceding three funicle segments together.

Thorax dark, sparsely setose; axillae triangular, meeting medially. Fore wings (fig. 1, C) hyaline, two and a half times as long as wide; costal cell narrow; submarginal vein long, with 10 long setae; marginal vein longer than postmarginal and stigmal veins separately (fig. 1, D); marginal fringe short, spaced by a distance equal to one-fourth their length. Hindwings hyaline, about five times as long as wide. Legs pale yellow except coxae dark brown; midtibial spur as long as basitarsus.

Abdomen dark brown except base of dorsum, and venter yellowish brown, shorter than thorax; paratergites absent (fig. 1, E); subgenital plate (fig. 1, F) with anterior margin straight, posterior margin with a wide notch medially; ovipositor (fig. 1, G) short, arising from apex of abdominal venter; first valvifer triangular, third valvulae movably articulated with second valvifers.

Body length: 0.82 mm.

COMMENTS. The new species is closely related to *Parasyrpophagus lindus* Mercet (Hayat & Verma 1978), from which it can be separated by its having antennae with pedicel shorter than basal two funicle segments together, all funicle segments much longer than wide, fore wings with postmarginal vein much longer than stigmal vein.

Holotype ♀, INDIA: Uttar Pradesh, Aligarh. University Agricultural Farm, 4.ix.1982 (*Anis Fatma*).

ACKNOWLEDGEMENT

We are indebted to Prof. Nawab H. Khan, Chairman, Department of Zoology, for providing research facilities.

[1] Accepted May 1984.

[2] Department of Zoology, Aligarh Muslim University, Aligarh, India.

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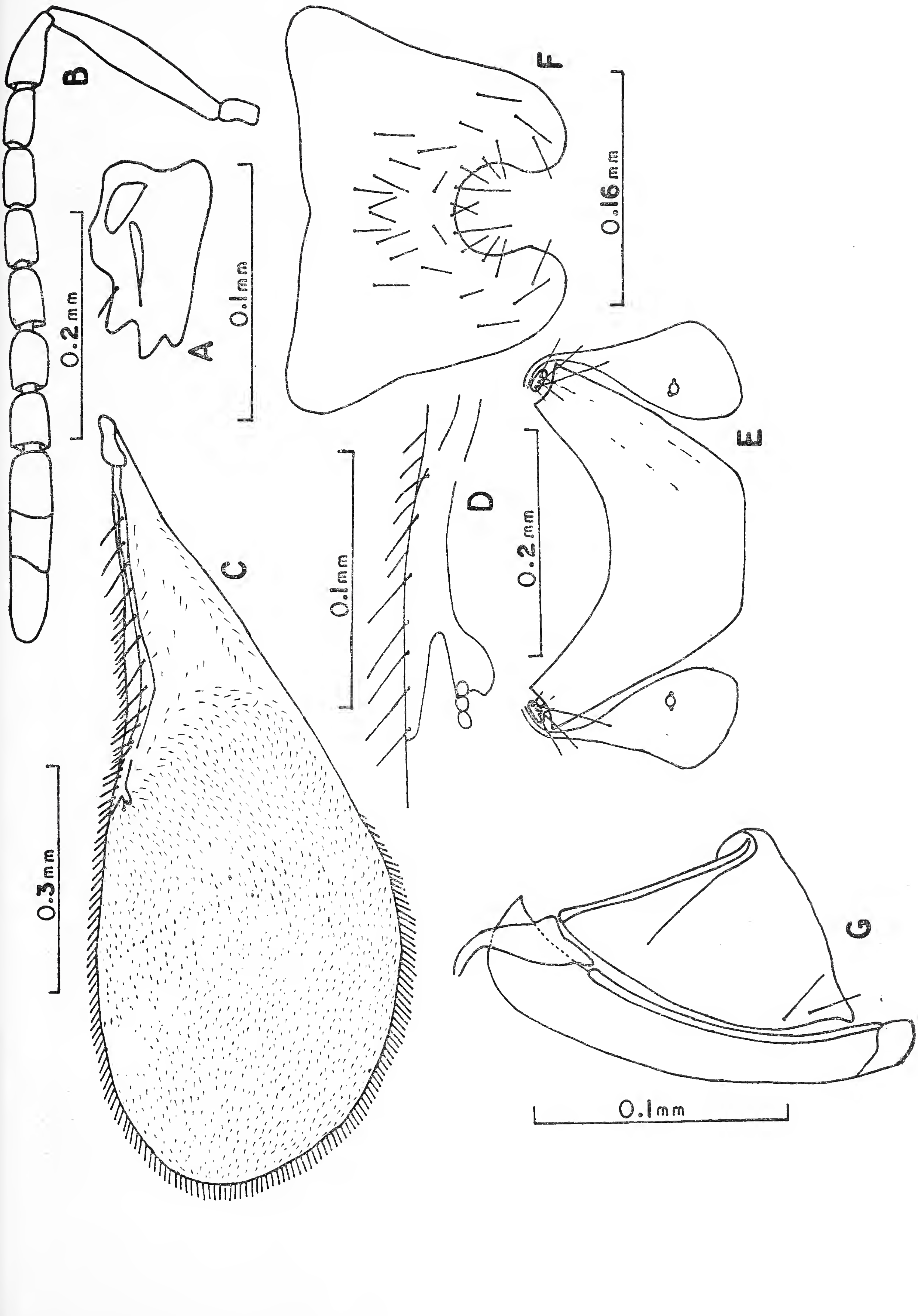

Fig. 1. A-G. *Parasyrpophagus aligarhensis* sp. nov.
(A) Mandible; (B) Antenna; (C) Fore Wing; (D) Part of fore wing venation; (E) Apex of abdomen, dorsal view; (F) Subgenital plate; (G) Part of external genitalia.

A NEW COBITID FISH OF THE GENUS *ABORICHTHYS* CHAUDHURI (PISCES: COBITIDAE) FROM INDIA[1]

R. P. BARMAN[2]

(*With a text-figure*)

INTRODUCTION

Chaudhuri (1913) established the genus *Aborichthys* with *A. kempi* as the type species from the Abor Hills, Assam. Subsequently Hora (1921, 1925) described two more species, *A. elongatus* from the base of Darjeeling Himalayas and *A. garoensis* from Tura, Garo Hills, Assam. The genus *Aborichthys* is so far known from these three species only. During the course of studies on fish fauna of Namdapha Wildlife Sanctuary, Tirap district, Arunachal Pradesh (formerly NEFA), I have come across three interesting fish specimens which, on critical examination, prove to belong to an undescribed species of the genus *Aborichthys*. This new species is named after Dr. B. K. Tikader, Director, Zoological Survey of India.

The new species comes nearer to *A. garoensis* Hora in having vent distinctly towards the tip of snout than to the base of caudal fin, but can be easily separated from the latter by the possession of deeper body depth, shorter eye diameter and less number of lateral coloured bands.

MATERIAL. *Holotype* (Fig. 1): 100.0 mm in standard length. Reg. No. Zoological Survey of India, Calcutta, FF 2135.

Locality. Namdapha wildlife Sanctuary, Arunachal Pradesh.

Collector. S. Biswas and party. Date of collection 12.12.83.

[1] Accepted August 1984.

[2] Zoological Survey of India, Calcutta-700 016.

Paratypes, 2 exs., 104.0 mm-110.0 mm. S. L. Reg. No. Zoological Survey of India, Calcutta, FF 2136. Locality, Collector and date of Collection are same as holotype.

Aborichthys tikaderi sp. nov.

Body greatly elongated and compressed. Body and caudal peduncle are uniform in height throughout so that dorsal and ventral profile of the fish are almost parallel and horizontal. Head depressed, length 5.77 to 5.88 and body depth 7.69 to 8.00 in standard length. Eyes small, diameter 8.50 to 9.00 in head length, 3.50 to 4.00 in snout length and 2.40 to 2.50 in interorbital distance. Snout subconical anteriorly equal in length to postorbital part of head, length 2.25 to 2.43 in head length. Nostrils situated close to inner, anterior border of eye, the membrane between two nostrils produced into a short barbel — like projection. Mouth slightly behind tip of snout and bordered by thick, papillated lips, which hang loosely and prominently at angles of mouth. Lower lip interrupted in middle and greatly on each side. Barbels 3 pairs — 2 pairs rostral and 1 pair maxillary. All barbels of equal length and equal to eye diameter. Vent situated far forward being distinctly nearer to tip of snout than to base of caudal fin. Lateral line incomplete, reaching before base of pelvic fin.

Fins. D. ii/7, A.6, P.11, V.8, C.18.

All fins widely separated from one another, Paired fins horizontal and provided with thick cutaneous pads in the nature of adhesive tissue on ventral aspect of some of their rays. Dorsal

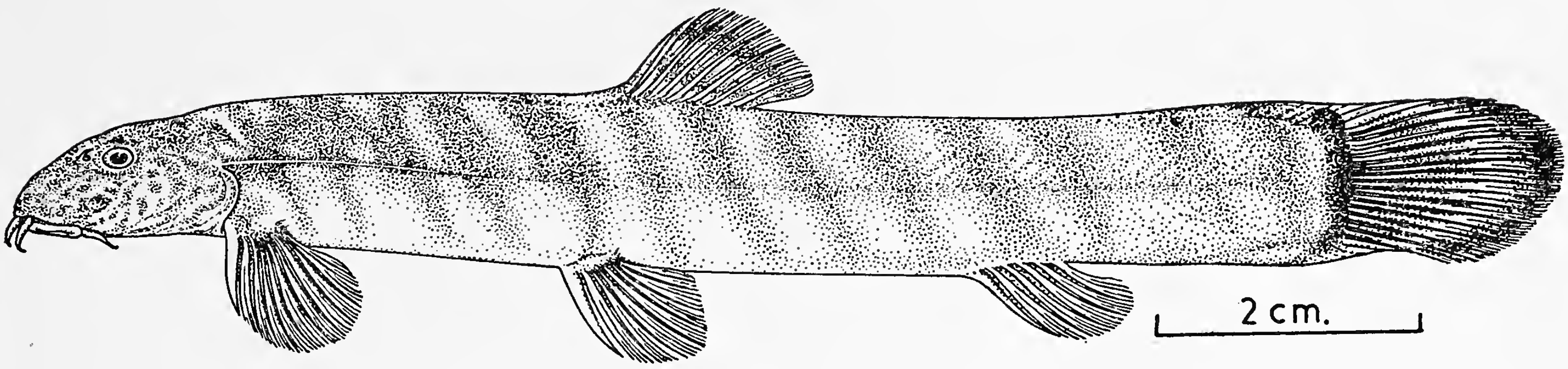

Fig. 1. Lateral view of holotype of *Aborichthys tikaderi* sp. nov.

fin small, its origin slightly behind that of pelvic fin and considerably nearer to tip of snout than to base of caudal fin. Longest ray of dorsal fin is slightly shorter than body depth immediately below it. Anal fin nearer to base of caudal fin than to commencement of pelvic fin. Pectoral fin considerably shorter than head length, its length 1.38 to 1.40 in head length. Pectoral fin situated at a distance more than double the length of pectoral fin from pelvic fin. Pelvic fin slightly shorter than pectoral fin and situated away from the anal fin by a distance equal to two and a half times their own length. Caudal fin long and more or less rounded posteriorly, rather asymmetrical, its length equal to or slightly longer than head length.

Scales. Entire body covered with small, elliptical scales. Scales on ventral surface rather inconspicuous but are prominent in posterior region of body.

Colour in alcohol. Body pale olivaceous coloured. Dorsal surface of head marked with short black lines which anastomose with one another. Body marked with 15 to 20 black vertical bands which encircle the body almost completely except a very short space on ventral surface. Black bands and yellow interspaces are almost of equal width. A black spot present at superior margin of caudal fin.

TABLE 1

Characters	*A. tikaderi* sp. nov.	*A. garoensis* Hora
Standard length/Body depth	7.69-8.00	9.50-10.00
Head length/Eye diameter	8.50-9.00	6.60-7.20
Caudal fin	Equal to head length	considerably longer than head length
Pectoral fin	Situated far away from pelvic by a distance more than two times of their length	removed from pelvic by a distance equal to their length
Pelvic fin	Removed from anal by a distance equal to two and a half times their length	away from anal fin by a distance equal to one and a half times their length
Body with vercal bands	15-20 bands which almost encircle the body	30-35 bands which generally anastomose dorso-laterally

MEASUREMENTS IN MILLIMETRES

	Aborichthys tikaderi sp. nov.			*Aborichthys garoensis* Hora** from type series		
	*1	2	3			
Standard length	100.0	104.0	110.0	89.5	89.3	85.8
Length of caudal	17.0	18.5	18.0	16.0	15.8	15.7
Length of head	17.0	18.0	18.0	14.5	13.9	13.3
Depth of body	13.0	13.0	14.0	9.0	9.2	9.0
Eye diameter	2.0	2.0	2.0	2.0	2.0	2.0
Snout length	7.0	8.0	8.0	6.6	6.6	6.2
Interorbital distance	4.8	5.0	5.0	3.8	4.0	3.0
Height of head at occiput	9.0	9.4	9.0	7.7	7.5	7.0
Width of head	11.2	11.8	12.0	10.8	10.8	10.6
Length of caudal peduncle	22.0	24.0	26.0	21.0	20.4	18.5
Least height of caudal peduncle	11.0	12.0	13.0	8.8	8.5	8.3
From tip of snout to vent	48.0	50.0	53.0	44.4	44.2	42.5
From vent to base of caudal	51.0	54.0	60.0	45.0	45.0	43.3
From tip of snout to commencement of dorsal	44.0	45.0	49.0	39.6	39.0	37.5
From commencement of dorsal to base of caudal fin	57.0	60.0	61.0	49.8	50.6	48.0
From tip of snout to commencement of ventral fin	41.0	44.0	44.0	35.5	36.0	34.7
Longest ray of dorsal	12.0	12.0	13.0	11.5	10.8	9.6
Longest ray of anal	10.0	11.0	12.0	10.3	8.6	8.0
Length of ventral	12.0	12.0	12.0	11.5	10.5	11.2
Length of pectoral	12.2	13.0	13.0	12.0	11.3	11.8
From commencement of pectoral to that of ventral fin	26.0	28.0	27.0	23.5	23.0	22.6
From commencement of ventral to that of anal fin	30.0	30.0	37.0	28.0	27.3	26.0
From commencement of anal to base of caudal fin	28.0	28.0	33.0	26.3	25.3	23.8

* Holotype

** After Hora, S. L. 1925. *Rec. Indian Mus. 27*: 236.

Pectoral, pelvic and anal fins dull white coloured. Dorsal fin provided with two or three rows of black spots across their rays. Caudal fin dull grey coloured with a semicircular black margin posteriorly.

AFFINITIES

Aborichthys tikaderi is related to *Aborichthys garoensis* Hora in having vent distinctly nearer to tip of snout than to base of caudal fin, but can be easily separated from the latter by the characters given in Table 1.

KEY TO THE SPECIES OF THE GENUS *Aborichthys* Chaudhuri

1. Vent almost equidistant between tip of snout and base of caudal fin or slightly nearer to tip of snout than to base of caudal fin...........2
— Vent distinctly nearer base of caudal fin than to tip of snout.............................3
2. Body depth 9.55 to 10.00 in standard length; eye diameter 6.60 to 7.20 in head length; lateral black bands 30 to 35...*A. goroensis* Hora
— Body depth 7.69 to 8.00 in standard length; eye diameter 8.50 to 9.00 in head length; lateral black bands 15 to 20 ....*A. tikaderi* sp. nov.
3. Vent nearer to tip of snout than end of caudal fin. Barbels much longer than diameter of eye. Black bands narrower than yellow interspaces ....*A. kempi* Chaudhuri
— Vent equidistant between tip of snout and end of caudal fin or nearer to the latter than to former. Barbels as long as or slightly longer than eye diameter. Black bands broader than yellow interspaces. ....*A. elongatus* Hora

ACKNOWLEDGEMENTS

I thank Dr. B. K. Tikader, Director and Dr. K. C. Jayaram, Joint Director, Zoological Survey of India, Calcutta for laboratory facilities to work and for encouragement. I am also thankful to Dr. A. K. Ghosh, Deputy Director & Dr. P. K. Talwar, Superintending Zoologist, Zoological Survey of India for their suggestions.

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REVIEW

FLOWERS OF THE HIMALAYA. By Oleg Polunin & Adam Stainton. pp. xxx+443 (22×14 cm), with pp. 445-518 illustrations and 128 coloured plates. New Delhi, 1984. Oxford University Press. Price Rs. 350.00.

This is the most colourful and eye-catching book on Himalayan flowers so far produced. As the authors have rightly pointed out in the bibliography there was no book so far, available which could be carried in the field, in the Himalayas, and used for the identification of plants. This book is in partial fulfilment of this need.

The book, which is basically designed for laymen and keen naturalists, describes over 1500 species out of about 9000 probables in the area. The book has been prepared on the same pattern as of "Flowers of the Europe, A field guide" by the senior author. It covers complete Nepal and three Indian high altitude states namely Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh.

The 960 colour pictures are of course the major attraction of the book but in addition there are 315 black and white sketches made by Ann Farrer.

The text of the book is based on Bentham & Hooker's system of classification and species descriptions are brief for the understanding of common man. However, while going through the text one gets the impression that the book is written mainly for the naturalists from the west, and lacks local information especially the local names of plants, which would have been appropriate.

On page 151, Pumpkin & Gourd, the common English names of *Cucurbita maxima* Duchesne and *Cucurbita pepo* DC. respectively have been interchanged. Similarly, on plate 9, photograph no. 70 is labelled as *Clematis roylei*, which looks like one of the Caryophyllaceae and requires rechecking.

On the whole, the book is a very useful addition to Indian Botany. The price is rather high, but reasonable for Institutions.

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. STRANGE BEHAVIOUR OF A TIGER

On 9th June, 1983 at around 6.00 p.m. we spotted a full grown tigress sitting near the nullah of Lakarda in Ranthambore National Park in Rajasthan. Her stomach was full and she was undisturbed by our presence in the jeep, actually she appeared to be too lethargic to move. We watched her for a few minutes and drove off but she continued to sit unperturbed. Mr. Fateh Singh Rathore, Field Director, Project Tiger, observed that this tigress had three nearly full-grown cubs and she frequented this area.

Next morning around 7.00 a.m. we went to the spot again. It was a cloudy but hot summer day. The tigress was found sitting not far from the nullah in the grass near her partially eaten sambar kill. While her cubs were not observed, only the head and the front legs of the kill had remained from the previous day's eating. It had also started smelling and was infested with flies and maggots. Unlike the previous evening, on seeing us the tigress was disturbed. She picked up the kill and walked away. We followed her in our jeep at a distance.

She moved straight for the Lakarda nullah less than hundred odd yards away and entered the water. Her manner showed a definite purpose. The kill was in her mouth all the while. She stood in the water for a while with the lower part of the kill dangling in it. Then quite deliberately she dunked the kill three successive times in the water as if to get rid of the fly nuisance. She settled down in the water for a while, then got up with the kill still in her mouth walked towards a bush on the bank of the nullah and hid the kill under it. She went back to the water, sat down partly in it and went to sleep quite oblivious of our presence in the jeep.

This entire episode took place in some 15-20 minutes between 7.00 a.m. to 7.30 a.m. After the tigress dozed off, we left the area. She, however, was observed by us at the same spot in the afternoon and evening of 10th June and again on 11th morning in the nearby grass. She had just killed and eaten a peacock before we arrived around 7.00 a.m. After a while she moved off.

Tigers are known to love water in the summer heat and they do carry their kills with them into the water. I had never heard of a tiger or seen one cleaning out its kill in the water in the manner observed by us.

DIVYABHANUSINH

AREA-DIRECTOR,
NORTHERN REGION,
THE INDIAN HOTELS COMPANY LTD.,
THE TAJ MAHAL HOTEL,
NEW DELHI-110 011,
April 19, 1984.

2. ON THE PRESENCE OF THE PANGOLIN *MANIS CRASSICAUDATA* GRAY AND A FOX *VULPES* SP. IN KUTCH

(*With a photograph*)

The Indian Pangolin being strictly a nocturnal animal is not usually seen, and hence it is often thought to be rare or absent from any given place. I, for one, thought that it did not exist in Kutch. However on 14th October, 1983, I was told that the *mali* in the Collector's Office in Bhuj had found a Pangolin and had kept it in his house where it eventually died. After making enquiries I traced the dead animal to the local museum. It was a young female. Subsequently I learnt from local *shikaris* and villagers in the district that the Pangolin is found all over Kutch. In the Kutchhi dialect it is called *chhallo*, an apt name descriptive of the scales the animal has all over its body.

While on a trip to the Great Rann of Kutch on January 7, this year (1984), I saw a fox in a grassy patch about 8 km. west of Kuanvar bet. But as our vehicle was being driven quite fast, and the animal was running away, I was

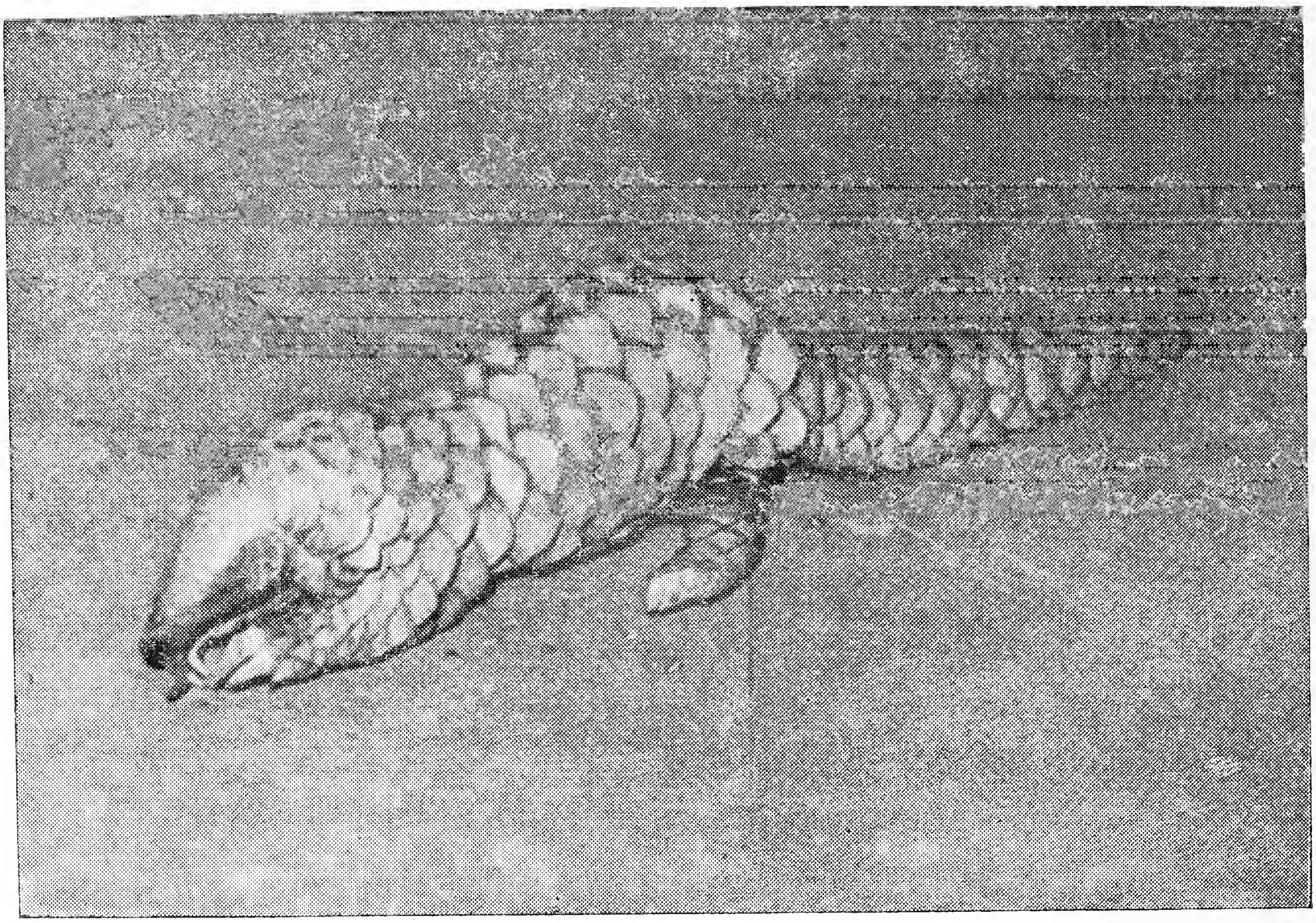

Photo. 1. The Indian Pangolin in Bhuj-Kutch, Gujarat.

unable to note details of the animals colour etc. However the most outstanding mark was a dark grey ring, or band, just above the black tip to the bushy tail.

HIMMATSINHJI

JUBILEE GROUND,
BHUJ, KUTCH,
May 12, 1984.

3. OBSERVATIONS ON UNUSUAL SEXUAL BEHAVIOUR IN ELEPHANTS

During our field studies at the Periyar Tiger Reserve two instances of unusual sexual behaviour were observed in wild elephants.

On 25th July 1979 a herd of elephants were grazing near the Periyar Lake shore at Manakkavala. There were two sub-adult tuskers in that herd. One tusker attempted to mount a female having a calf of about 2 years. The cow did not allow the subadult tusker to mount. The cow and the calf went towards the forest followed by the tusker. The tusker attempted to mount the cow again. The penis of the tusker was everted from its sheath throughout the period. The tusker continued to follow the same cow, with its trunk holding the tail of the cow and pulling it. The cow freed itself by moving forwards and hurriedly returned to the herd along with her calf. The tusker went to the other smaller tusker which was in knee deep water and smelled its penis with the trunk tip. The tusker then mounted the other tusker with its everted penis. The second tusker moved away and then they began pushing each other. The bigger tusker again mounted on the other tusker and after some time they left the water.

This kind of unusual sexual behaviour shown towards smaller individuals after several unsuccessful attempts to mount has been described by Eisenberg *et al.* (1971) in Asiatic elephants. They termed this behaviour as "redirected sexual activity".

In another instance on 20th February 1980 a tusker slightly bigger than the one described earlier mounted a female elephant with a calf of about 4 years, after an elaborate and prolonged session of courting for about one and half hours.

During the courting the calf was about 30 m away from its mother feeding on grass. After successful copulation the elephants moved away.

In the first instance the calf was probably too small and dependent on the mother. The elephant seems to adjust its calving interval in such a way that the previous, calf is fairly independent before the birth of the next calf.

In Periyar the subadult tuskers seem to get comparatively more opportunities for mating due to the fewer number of adult tuskers in the elephant population.

K. K. RAMACHANDRAN

WILDLIFE BIOLOGY DIVISION,
KERALA FOREST RESEARCH INSTITUTE,
PEECHI 680 653,
July 9, 1984.

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4. ADDITIONAL RANGE INHABITED BY BHARAL (*PSEUDOIS NAYAUR*) AND SNOW LEOPARD (*PANTHERA UNCIA*) IN NEPAL

We provide further information on the distribution of bharal (*Pseudois nayaur*) and snow leopard (*Panthera uncia*) in Nepal. Observations, incidental to trekking activities, were made during 1977-1978.

Both bharal (*Pseudois nayaur*) and snow leopard (*Panthera uncia*) have been subjects of recent popular accounts (Matthiessen 1978, Schaller 1979) and scientific reviews (Schaller 1973, 1977; Jackson 1979). Bharal occur mainly north of the central Himalayan massifs in Nepal and are largely limited to alpine areas west of the Kali Gandaki River (Schaller 1977). Snow leopard broadly overlap bharal in distribution (Schaller 1977, Jackson 1979), except in east Nepal where bharal distribution is more limited (Schaller 1977).

Schaller and Matthiessen saw bharal along the Seng Khola between Dhorpatan and Tarakot (Matthiessen 1978, Schaller 1979) and Wilson (in Jackson 1979) reported them as abundant in the former locality. However, we travelled those areas north to Phoksumdo Taal (Ringmo Lake) in November 1977 with no sign of the species except for a hide in the village of Murduwa, below Ringmo. From there we paralleled the northern slopes of the Dhaulagiri Range east to the Kali Gandaki River. Enroute we observed fresh tracks of a female snow leopard and her half grown cub at a spring near our camp site at 5300 m just north of the 5700 m Mu La pass. No sign of bharal was made until one of us (PMH) collected the horn of a male at 4950 m near Sangda La pass and later found the skull of a male at the entrance of Cha Lungpa Gorge (4600 m). No further evidence of either species was observed on that trek.

On 26 May 1978 we observed and photographed two herds of bharal with 12 and 3 individuals, respectively, between 4600 and 5050 m in an area west of Tilicho Lakes and due north of the Nilgiri-Annapurna massifs. Of interest is that the first group contained one newborn. This coincides with the period of parturition estimated by Schaller (1977). In this same area, PMH collected several snow leopard scats, all of which contained bharal hair. Slightly north, in the village of Kagbeni, we were shown the hide of a bharal and on the north flank of the Thorang La pass, above Muktinath, we observed another herd of 9 bharal at 4800 m. These are previously unrecorded populations east of the Kali Gandaki River. They may represent a southwestern extension of range (see Schaller 1977) or a part of a larger disjunct distribution that continues north in Mustang District. How far east bharal occur along the Annapurna Range is unknown.

In mid-October 1978 we camped on the east slope of the lower Jaljalle spur at 3900 m under a large rock overhang that was used by bharal, evidenced by fresh droppings and shed hair. This is the southernmost range inhabited by this species in east Nepal (Schaller 1977). The Jaljalle lie east of the Arun River and

extend north toward Tibet at elevations of 3500 - 4800 m. The vegetation is both krummholz and alpine while the western flank is blanketed with impassible thickets of dwarf bamboo (*Arundinaria*). We continued north to Sabhai Pokhari with no further sign of bharal. However, visibility was poor and bad weather forced us to return south.

Directly below this area on the upper Milke Danda, we found pugmarks of a large feline at 3650 m which we identified as either those of the common (*L. pardus*) or snow leopard. This is a transitional altitude for both species and the nearby occurrence of bharal, a favoured prey, would suggest that the Jaljalle are inhabited by snow leopard. However, several kilometres south a common leopard was observed (JHC) at close range on the crest of the Milke Danda at 3200 m. Both this and the preceding sightings were in rhododendron (*Rhododendron* spp.) thickets.

Our expeditions attest to the decline and scarcity of Himalayan wildlife. Combined, these treks lasted five months yet the only other large mammals encountered were a jackal (*Canis aureus*), several common langur (*Presbytis entellus*), and two barking deer (*Muntiacus muntjak*) in west, central, and east Nepal, respectively. Few populations of ungulates and carnivores in the Himalayan ranges are likely to exist at sustained levels outside of managed parks, preserves, or refuges. The Nepalese government has done a commendable job of establishing representative natural areas for conservation purposes, considering its economic resources. The Jaljalle and Tilicho Lakes areas are uninhabited and may represent critical habitat for bharal and snow leopard. We therefore urge His Majesty's Government and the Office of National Parks and Wildlife Conservation of Nepal to give priority consideration toward gazetting these areas in planning further conservation programmes.

ACKNOWLEDGEMENTS

We thank Bill Brandenberger and Ridge DeWitt for their good company on these expeditions and our various porters for the excellent services rendered. Robert L. Fleming, Sr. and Jr. greatly added to our enjoyment of Nepal with their insights and hospitality. We also thank Donald R. Johnson for reviewing the manuscript.

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5. A NOTE ON ANTLER CASTING OF BARKING DEER (*MUNTIACUS MUNTJAK*) IN CAPTIVITY

The Barking Deer or Muntjac (*Muntiacus muntjak*) are distributed over the greater part of the Indo-Malayan countries, China, Formosa and Japan (Prater 1971). This note on some aspects of antler casting of barking deer is based on the observations made at the Nandankanan Biological Park, Orissa during the period October, 1970 to March, 1983. The park is within the geographical range of the species. Specimens collected from different parts of Orissa and those born and brought up in the park are included in the study. The number of stags under observation varied from one to seven.

The thirty four antler castings recorded during the observation period were distributed as follows: March, 2; April, 20; and May, 12. Majority of castings (94.12%) were recorded in April and May only. The antlers are cast annually and never retained to the next year.

The fifty one observations on the period of Velvet rubbing were recorded as follows: August, 14; September, 26; October, 9; and November, 2. Majority of observations (78.43%) were recorded in August and September only.

The antlers of both sides were cast either in one day or within four days. Casting of both antlers was observed within one day in twenty instances (58.8%), on eleven instances within two consecutive days (32.3%), on one instance within three days (3%) and on two instances within four days (5.9%).

The period required from the time of casting of antlers to the time when the stags start rubbing off the velvet is taken as the span of antler growth. This period recorded on 12 occasions varied from 4½ to 6½ months (4½ months on three occasions; 5 months on one occasion; 5½ months on seven occasions and 6½ months on one occasion).

The weight and measurements of ten cast antlers are given as follows:

Length in cm	Weight in gm
5.00	7,400
6.50	8,600
7.00	11,500
7.75	12,500
10.00	17,000
10.00	17,700
10.00	20,500
10.50	12,300
11.00	16,900
11.00	25,200

The small antlers were either unbranched or with a short brow-tine as reported by Prater (loc. cit.). The antlers are shed in May and renewed in August but it is doubtful whether this occurs annually (Asdell 1964). Antlers are shed annually in May in southern Asia and they rarely exceed 125 to 152 mm in length (Walker *et al.* 1964). The antlers are cast in May and June and the average Indian antlers measure 5 to 8 cm, and maximum recorded length is 17.8 cm (Prater, loc. cit.). According to Acharjyo (1971) nine antler castings were recorded in April and May and both the antlers were cast either in one or two consecutive days.

NANDANKANAN BIOLOGICAL PARK,
P. O. BARANG, DIST-CUTTACK.

L. N. ACHARJYO

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6. ON THE OCCURRENCE OF GREAT CRESTED GREBE *PODICEPS CRISTATUS CRISTATUS* (LINN.) IN COASTAL ANDHRA PRADESH

While on a nature trek to Thatipudi forest area and the reservoir situated in the foothills of Anantagiri ghats of Vizag District, on 27th February 1983, we observed a pair of Great Crested Grebes in the reservoir.

The reservoir is devoid of any marshy vegetation and very deep with abundant supply of fish. The pair of birds were 30 feet apart from each other at a distance of 50 feet from the impoundment bund with prominent crests visible to the naked eye. We also timed its submergence and recorded the longest dive as 130 seconds, between 0400-0430 p.m.

This constitutes the first record of this species for Andhra Pradesh and extends its known range by about 450 km southwards from the last coastal record at Puri on the East Coast (HANDBOOK 1: 3).

ANDHRA PRADESH NATURAL
HISTORY SOCIETY,
DASAPALLA HILLS,
VISAKHAPATNAM-3,
March 7, 1983.

K. S. R. KRISHNA RAJU
B. L. PRABHU
P. R. GOPALA RAJU

7. A NOTE ON THE CATCHING OF MIGRATORY BIRDS WHICH VISIT ALIPORE ZOO, CALCUTTA IN WINTER

(*With a photograph*)

Several thousands of migratory birds (wild ducks) visit the Alipore Zoological Garden, Calcutta each Winter and take shelter in its lake. These birds include the following —

1. Lesser Whistling Teal — [*Dendrocygna javanica* (Horsfield)]
2. Garganey Teal — [*Anas querquedula* (Linnaeus)]

3. Greater Whistling Teal — [*Dendrocygna bicolor* (Vieillot)]
4. Pintail Duck — [*Anas acuta* (Linnaeus)]
5. Comb Duck — [*Sarkidiornis melanotos melanotos* (Pennant)]

Among these birds, Lesser Whistling Teals come in large numbers and represent about 70% of the total population. The precentage of Garganey Teal is about 29% and the remaining 1% is represented by Greater Whistling Teals, Pintail Ducks and Comb ducks. They generally start coming in the middle of October and leave the Garden at the end of April each year. The number of these birds in the Zoo varies from time to time but the number of birds is generally seen in the month of January.

The birds during their stay at the Zoo spend the day in the lake and leave at dusk to feed many miles away in the countryside and come back to the lake at dawn. These movements of birds at dusk and at dawn take place throughout their stay (about 6 months) at this Zoo.

It has been observed that some people of the nearby Orphanage market area fly Kites, the threads of which are full of fishing hooks tied at intervals of 6 to 8 inches (as shown in the plate) with the threads for catching the birds. The kites are flown in the evening

Photo. 1. Photograph of a kite showing fishing hooks being tied with the flying string.

and also in the early morning on the flight paths of the duck. These birds generally fly in flocks, of 5 to 15 birds in each flock. The bird-catchers fly the kites in such a way that they can easily put the threads with hooks on the flight paths of the birds by alternately pulling and releasing the kite's string. Some of the ducks during their flight to and from the lake of the Zoo become entangled with the fishing hooks and are caught.

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to Shri Humayun Abdulali, 75, Abdul Rahman Street, Bombay-400 003 for his encouragement.

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8. THE JUVENILE PLUMAGE OF THE LITTLE EGRET COMPARED WITH THAT OF THE WHITE-PHASE INDIAN REEF HERON

(*With a text-figure*)

The Little Egret, *Egretta garzetta* (Linn.), is mainly an inland species which is replaced by the polymorphic Indian Reef Heron, *Egretta gularis* Bosc, on the western coast of India. Whether these two are separate species or merely the inland and coastal races of the same species, has not been satisfactorily resolved as yet. In their recent study on the systematics and evolutionary relationships among the herons, Payne and Risley (1976) have considered *E. garzetta* and *E. gularis* as members of a superspecies.

The Little Egret resembles the white-phase Reef Heron. A far-inland population of the Little Egret can be clearly distinguished from an exclusively marine Reef Heron population, as the former is characterized by the presence of a black beak whereas the latter has a yellow beak. However, in the transitional zone where both the marine as well as the inland waters are important sources of food, the distinction between the two species based on the beak colour breaks down and the white birds with the beak colour ranging from jet black to yellow can be seen interbreeding with the grey morphs of the Reef Heron in the same heronry (Parasharya & Naik, *unpublished*). That there is a considerable overlap between the tarsus length of the Reef Heron and Little Egret has been demonstrated earlier (Ali & Ripley 1968, Hancock & Elliot 1978). In view of these, we thought it desirable to check the contention of Ali & Ripley (1968) that the Little Egret has 'snow-white' chicks in contrast to the Reef Heron whose white chicks are dappled with grey.

MATERIALS AND METHODS

A heronry in the grounds of the Municipal Hill Garden Zoo, Ahmedabad (23° 04′ N, 72° 38′ E) located about 92 kilometres from the sea coast was visited on 28 September 1982. The Little Egret was breeding there along with the Large Egret (*Egretta alba*), Median

Egret (*Egretta intermedia*), Cattle Egret (*Bubulcus ibis*), Night Heron (*Nycticorax nycticorax*), Pond Heron (*Ardeola grayii*) and Little Cormorant (*Phalacrocorax niger*). After careful observations of adult birds attending their nests, four nests of the Little Egret were identified and from these nests six 2 to 3-week old chicks (three from one nest and one from each of the other nests) were collected and transported to an aviary in the Saurashtra University Campus, Rajkot, where the birds were maintained for a detailed study. We have had for a comparison several white morphs of the Indian Reef Heron in their juvenile plumage in the aviary; these birds were collected from a Reef Heron colony in Gogha (Naik *et al.* 1981) on the west coast of the Gulf of Khambhat.

Results

The three siblings of the Little Egret had a number of white feathers with grey streaks and dapples; only the head, breast, abdomen and thigh had all the feathers pure white, the other regions having had most of the white feathers streaked, or dappled, with grey at the distal ends. Out of the other three nestlings collected, one had feathers with grey streaks and dapples

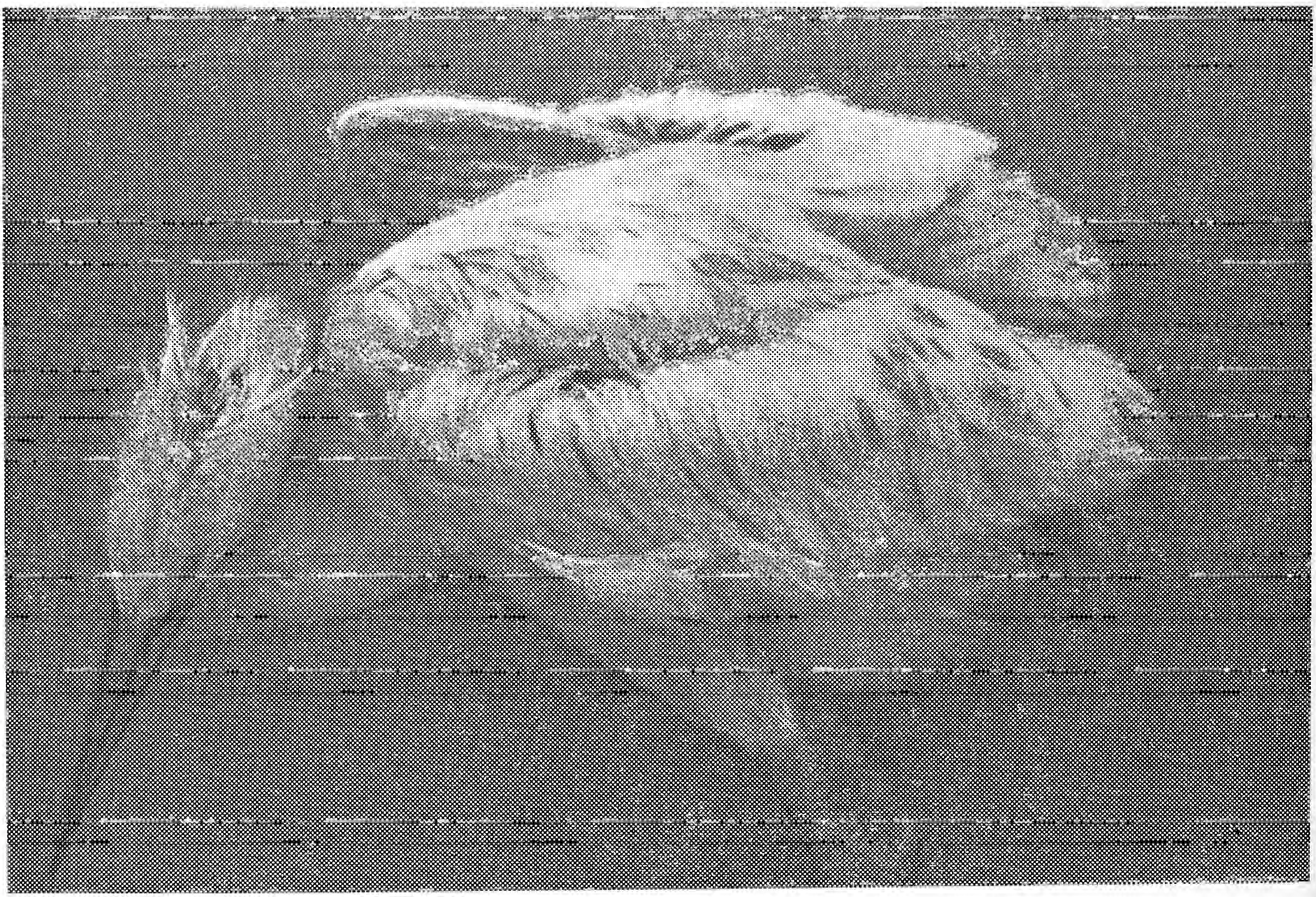

Fig. 1. A nestling of the Little Egret showing grey streaks and dapples on the plumage.

as described above, whereas the remaining two nestlings had exclusively pure white feathers all over their body.

The juvenile plumage in the white morphs of Reef Heron had variable amount of grey in the form ranging from fine streaks to large dapples. Some of these birds resembled the Little Egrets with grey streaks and dapples described hereinbefore.

Discussion

The juvenile plumage of Little Egret is not always pure white, though it might be so in some individuals. On the other hand, the white-phase Reef Heron always has some amount of grey in the form of streaks and dapples in its juvenile plumage (Naik & Parasharya 1983) we have handled a large number of chicks of the Reef Heron without ever finding a chick with pure white plumage.

The white juvenile plumage is extremely variable within the Little Egret-Reef Heron complex and the Little Egret represents one end of the broad spectrum of variability. This is true with respect to the other physical characteristics, such as beak and leg colour (Parasharya & Naik, *unpublished*) as well.

The Little Egret and Reef Heron are allopatric in the transitional zone between inland and coast and we have circumstantial evidences that these two species interbreed there (Parasharya & Naik, *unpublished*). If the pure-white juvenile plumage is the genotypic characteristic of the Little Egret, as against the grey-splashed juvenile plumage of the Reef Heron, it is possible that the Little Egret would have only the pure-white juvenile plumage represented in its populations that are far removed from the sea coast. Both the pure-white as well as grey-splashed juvenile plumages, however, may be encountered in the populations relatively closer to the coastal areas, because of a regular gene flow from coastal populations of the Reef Heron. Our investigations currently in progress, are directed towards checking this possibility.

Acknowledgements

We are grateful to Mr. H. G. Gor, Zoo Superintendent, Municipal Hill Garden Zoo, Ahmedabad, for providing facilities to collect birds. A Junior Research Fellowship given by CSIR, New Delhi, to one of us (B.M.P.) is acknowledged.

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9. UNUSUAL FEEDING BEHAVIOUR IN THE PADDYBIRD OR INDIAN POND HERON *ARDEOLA GRAYII*

During a visit to the Parambikulam Wildlife Sanctuary, Kerala State, in December 1982 our attention was drawn to two unusual kinds of feeding behaviour in the Paddybird *Ardeola grayii.*

Within that sanctuary water from the 23 sq. km. Parambikulam dam feeds into the *c.* 3 sq. km,, Thunacadavu dam through a 2 to 3 km long tunnel under high ground. The exit of the tunnel lies at the head of a small inlet or creek which extends for some 30 m and broadens from 5 to 15 m before opening into the lower dam proper. The banks of the upper part of the creek are steep and overhung by small trees, but nearer its mouth these give way to the same flat, open pebble and mud beaches that surround the rest of the dam. The water in the creek is deep and fast flowing, but not turbulent, and its current can be traced for a further 200 to 300 m out into the otherwise calm waters of the dam. The dam is heavily stocked with Carp and *Tilapia* spp. which tend to congregate towards the head of this flow of fresh water. Mahseer *Barbus tor* are also present and feeding flurries of these predatory fish, which surge right up to the mouth of the tunnel, cause frequent showers of small 5 to 10 cm long fish to leap into the air, apparently throughout the day.

The creek, which is near the small resthouse in which we were staying, was visited at intervals from the afternoon of the 1st to the early morning of the 3rd December and on each occasion from 15 to 25 Paddybirds were found to be congregated there, although none were to be seen on the open shores of the dam. Those birds were perched either on low branches near to or overhanging the water or on a small group of boulders near the mouth of the creek. Every few minutes one or more of them would take off and fly low over the water of the creek in an attempt to catch the leaping small fish on the wing. Flights were usually short and not more than 25 to 40 m in length, in the course of which a bird might swerve in pursuit of several different showers of fish before returning to the same or another perch. At no time was a bird seen to enter or make contact with the water. The rate of success in this method of fishing appeared to be low and on only three occasions during a total of perhaps 1½ hours of watching was a fish actually seen to be taken, although other captures probably occurred which were not observed. All fish caught were taken to a perch before being eaten. Although several birds might be in the air at once, fishing appeared to be a purely individual effort and no kind of collaboration was observed.

Much less frequently a single Paddybird, or occasionally two, would take off and fly out along the visible current line in the dam proper at a height of from 15 to 30 m. There they behaved in a rather clumsy, tern-like manner, quartering the water, attempting (not too unsuccessfully) to hover, and occasionally stooping towards its surface, presumably after the less frequent showers of fish that were leaping there as well. The distance was too great for it to be seen if any fish were actually taken but on one occasion a bird was seen to alight on the water after such a stoop, which may have indicated success. Such flights over the dam rarely lasted for more than a minute or two.

On the 2nd December similar tern-like feeding behaviour was observed in the same species on the larger Parambikulam dam. On that occasion from three to five Paddybirds at

a time were watched circling, half hovering and occasionally stooping over each of the two patches of disturbed water where flocks of Cormorants *Phalacrocorax carbo* were fishing submerged and occasionally surfacing, presumably again causing shoals of little fish to leap into the air. At no time was a Paddybird seen to make contact with the water at the end of a stoop but on three occasions one was observed afterwards to alight on it, although the distance was too great to see if it had anything in its beak. Both areas were more than half a kilometre from the shore and each Paddybird spent several minutes circling over one or other of them before returning to rest on the beach or in a group of dead trees standing in the water.

Neither of these two methods of feeding appears to have been described in this species before, although tern-like behaviour has been recorded in other Ardeidae, notably the Eastern Reef Heron *Egretta sacra*, the Intermediate Egret *E. intermedia* and the Snowy Egret *E. thula* (Sir Hugh Elliott, *pers. comm.*). The pursuit of leaping fish during short flights from a perch, which can perhaps be compared to the "bellyflopping on the water from an overhanging stone ledge" behaviour referred to in Ali and Ripley, is probably an adaptation to a particularly favourable local situation, because there can be few other places where abundant shoals of small fish are forced into the air so close to a bank with such day-long regularity. If that is so the habit must be of fairly recent origin, because the Parambikulam dams were only completed in 1967 and, although they are understood to have been stocked shortly afterwards, it would be several years before fish populations could build up to the levels required to produce the present situation. However the habit is at least seven years old because we were told by both Mr. Jayarajan, the present warden, and Mr. V. Sadasivan, his predecessor, who have between them served continuously in the sanctuary since 1975, that they have regularly watched Paddybirds feeding in the creek in the manner described since they were first posted there. They also reported Paddybirds to have fed in a tern-like way on the open waters of both dams throughout the same period, although neither of them has seen either behaviour in the species elsewhere.

We are most grateful to Mr. Jayarajan and Mr. Sadasivan for drawing our attention to the above phenomena and to Sir Hugh Elliott for help in the preparation of this note.

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10. ON THE SIGHTING OF A FLOCK OF CRAB PLOVERS AT KOLHAPUR

On the 27th March 1983 we were at the Rankala Tank (200 ha) on the outskirts of Kolhapur (17° 32′ N latitude and 74° 14′ E longitude), Maharashtra. At 9 O'clock in the morning we saw a flock of unfamiliar black-and-white birds flying very low over the tank. Our curiosity being aroused, we went across for a closer look, to the opposite bank, over which the birds were persistantly circling.

The birds numbered about twentyfour in all and flew swiftly with strong wing-beats in a tight but constantly changing formation. Their flight path seemed to hug the periphery of the tank, making irregular circles over the shallower areas. We watched this wheeling for more than an hour, and they were still in flight when we left. Throughout the morning they had not settled on the ground. Subsequently the birds have not been seen on the tank or anywhere else in the vicinity.

The birds were primarily white, with a black back and greyish black wings. The bill was short, thick and black, and their longish grey legs trailed behind them. The flock was a beautiful sight and the photographs also confirm that they were indeed Crab Plovers.

The fascinating aspect is the occurrence of these maritime birds so far inland at Kolhapur, which is about 60 miles in a straight line east of the sea, and is separated from it, by the Western Ghats. Crab Plovers are being commonly found only in the coastal areas by and large north of Ratnagiri.

How or why these coastal birds have chosen to move inland is a mystery. However, we have found that tanks such as Mayni in Satara district, which is even further inland do attract birds such as sea gulls and perhaps our Crab Plovers followed them inland. Recently a sea gull was also spotted by one of us at the Mula Mutha Bird Sanctuary in Pune where they have never been seen before.

We feel that increasing sightings of such seaside birds, far away from their usual home, might indeed indicate subtle changes in their coastal habitat which at present may not be overtly visible.

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JAY S. SAMANT

[Instances of shore birds being found far inland than their usual haunts have been recorded in the *Journal* from time to time. The occurrence at Nasik of a Red Sea Masked Gannet *Sula dactylatra* Lesson was reported in July 1957 (JBNHS 55: 358). Earlier in June/July 1957 large flocks of that rather rare Great Skua *Catharacta skua lonnbergi* Mathews arrived in Malwan on the Ratnagiri coast.

Nasik is about 70 miles and Kolhapur about 60 inland respectively from the nearest sea coast. Perhaps the fact is there were lesser number of knowledgeable birdwatchers in the country not so long ago resulting in such strays going unnoticed and unrecorded in the past. — Eds]

11. CRANES WINTERING IN SAURASHTRA

In January-February 1983 I had an opportunity to travel in the Saurashtra region of Gujarat in the company of Dr J Van der ven, chief of the Nature Conservation Department in the Netherlands. In visiting the wetlands and reservoirs of Saurashtra, our main purpose was to look for the wintering numbers of Demoiselle (*Anthropoides virgo*) and Common (*Grus grus*) cranes; but such was the richness of the avifauna encountered, that it was impossible to restrict oneself merely to cranes. However, cranes being our first concern, the estimated numbers of cranes observed at different reservoirs are given below:

Date	Name of Wetland	Number of Demoiselle	Number of Common	Number of Sarus
27 Jan.	Lalpari (Rajkot)	5000	Nil	Nil
„	Veri (Gondal)	Nil	25	2
28 Jan.	Sayala	250	300	4
„	Thoriari	35	Nil	Nil
„	Muli	2000	Nil	Nil
29 Jan.	Kharaghoda (Little Rann)	Nil	3000	Nil
31 Jan.	Vijaysagar (Kutch)	Nil	25	6
31 Jan.	Jodiya	Nil	12	2
1 Feb.	Singach	100	Nil	Nil
2 Feb.	Alansagar (Jasdan)	1000	Nil	Nil
„	Ponelia	Nil	7	Nil
„	Brahmani	25	Nil	Nil
3 Feb.	Nyari (Rajkot)	3000	Nil	Nil
4 Feb.	Mitana (Morvi)	3000	400	Nil
„	Ramdarda (Rajkot)	500	Nil	Nil

(The estimates are rounded to the nearest hundred.)

In addition small flocks of Common cranes numbering 10 to 25 birds were observed in flight several times. Distant views of large flocks believed to be of Demoiselles, were also seen especially around Rajkot and Jamnagar. In all, we must have seen an estimated 25,000 cranes belonging to both the species. Pairs and small flocks of Sarus were also seen. But Sarus appears to have a very dispersed distribution and is by no means common in Saurashtra.

Sightings of cranes indicate that Demoiselles were more common in the west while, as you travel from west to east, the Common becomes more numerous.

The daily routine of cranes appears to be as follows: The cranes leave roosting areas which are normally on the banks of reservoirs, early in the morning to feed in fields on fallen groundnut of previous harvest. They return to the roosting sites between 10.30 and 11.30 a.m. to spend the noon and afternoon there. In the evening around 5 p.m. they go out again to feed and return to the roost in gathering dusk. Common cranes were also seen feeding in *jowar* and *gram* fields.

A number of juveniles were seen among flocks of Common cranes, though not many among Demoiselles. On two occasions a Demoiselle pair with a young was seen feeding away from the main flock.

On the whole, cranes permitted a fairly close approach and were not unduly scared by our presence. In certain areas like Sayala, where they are protected by the local people, they were even tamer.

All the reservoirs and wetlands also presented a rich diversity of aquatic birds. Shovellers were seen to outnumber all other ducks, though sizeable numbers of Pochard and Tufted Duck were seen. Over two thousand White and a few Grey Pelicans were also seen. The Khijadiya wetland encompassing freshwater and saltwater habitats, is extremely rich in waterbirds including Pelican, Greater and Lesser Flamingo, storks, heron and egrets, various ducks, avocets and curlews

and other waders, coots and moorhens. This extensive marshland may very well be a candidate for inclusion in the Ramsar list as a wetland of international importance.

The lake in the centre of Jamnagar, a busy industrial town, is a veritable paradise for birdwatchers. Scores of Greater Flamingos, hundreds of ducks, waders, terns and coots and many cormorants, darters, ibises and moorhens, not to say skimmers, crowd this shallow lake.

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May 4, 1983.

PRAKASH GOLE

12. A NOTE ON THE STATUS OF *BRACHYPTERYX CRYPTICA*

In March 1979, in the Tirap District of Arunachal Pradesh, our joint Smithsonian-Bombay Natural History Society Expedition collected a series of five specimens of a bird species which Dr Sálim Ali and I assumed we had not previously encountered in our Indian field studies. It was a small, buff-brown, undistinctive chat-like bird, which I subsequently described as a new species of shortwing thrush, *Brachypteryx cryptica* (Ripley, 1980). I postulated that this new form was most closely related to the poorly known *Brachypteryx hyperythra*, from Sikkim and northeastern India.

On returning to Arunachal Pradesh for continued ornithological field investigation in December-January 1981-82, we collected four more specimens, noting in one case the typical chat-like stance of an individual standing on an exposed rock. Later in Calcutta we saw three more specimens collected by the Zoological Survey of India, eight months earlier, in 1981, these being identified as the new *Brachypteryx*. At this point, Dr. Sálim Ali and I began to have reservations. Could the species be a timaliine? In Washington, consultation with Dr Richard Zusi revealed the fact that the nasal operculum in our new species is only partly closed, thus resembling forms in the genus *Trichastoma* (a timaliine). Additional evidence, the degree of fusion of the basal phalanges of digits three and four (greater in *Trichastoma*), coupled with the slightly longer rictal bristles, placed these birds in that difficult timaliine genus. No specimens of *Trichastoma tickelli assamense* had been identified by us, although we had collected the species to the north in heavy undergrowth in the Mishmi Hills in 1946. Thus my supposed shortwing becomes a synonym of *Trichastoma tickelli assamense*.

None of the birds we collected uttered a sound, a factor which, added to the presence of other shortwings in the area, and none of the *Trichastoma abbotti* or *Pellorneum* which might have reminded us of *assamense* (the widespread *Pellorneum ruficeps* was of course common and noisy) served to throw us off the scent completely.

The boundary separating the smaller chat-like thrushes (Turdinae) from the similar small Indochinese babblers (Timaliinae) is poorly defined. *Trichastoma* is a timaliine genus generally considered to be on this borderline (Deignan 1964). A perusal of the original designations of many taxa now included in

Trichastoma shows that earlier workers have had difficulty separating the shortwing *Brachypteryx* from this babbler genus. *T. bicolor, T. rostratum macropterum, T. sepiarium, T. m. malaccense,* and *T. m. poligene* were all originally placed in the genus *Brachypteryx* by their describers. Thus even a wary ornithologist can be trapped. A further study of the generic limits of the genus *Trichastoma* is planned.

One final note on construction of names in the genus *Trichastoma*: Deignan has considered the genus name to be neuter, and has altered all modifying names accordingly. In order to bring the nomenclature of my A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN into accord with Deignan, species no. 1166 (p. 322, 2nd ed.) should read: *Trichastoma tickelli assamense,* (not *assamensis*).

ACKNOWLEDGEMENTS

Research in India was facilitated by the kind assistance of numerous authorities in the Wildlife Department and Government of Arunachal Pradesh. I thank curators at the American Museum of Natural History, Field Museum of Natural History, Museum of Zoology, University of Michigan, and Museum of Comparative Zoology, Harvard University for loaning comparative material in their care. Finally, thanks are due to Drs Sálim Ali and Richard Zusi who helped me to solve this provisional ornithological riddle.

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13. SOME NOTES ON THE BREEDING OF THE COMMON BAYA (*PLOCEUS PHILIPPINUS*)

On 12th October 1969, HA while looking for duck and snipe (which were not found!) in a marsh along the Shil-Kalyan Road, Thana District, near Bombay, saw large flocks of Bayas (*Ploceus philippinus*) flying from one patch of grass (*Coix lachryma-jobi*) to another. In one place, two birds in female plumage were seen carrying grass. Closer examination revealed seven or eight nests in various early stages of construction spread over a distance of about 20 yards in a patch of reeds 100 yards long and about 10 yards wide bordered by a knee-deep ditch of water along the side, where the nests were visible from outside. The nests were slung from one or two reed-stalks about 7 feet from the ground. They were not hung from a single point as are normal baya nests; the area of contact extended over three or four inches along the stalks. They also appeared to be of a coarser and looser texture.

None of them was complete. A male in breeding plumage which had settled a few feet from a nest was collected. This was found to be the Common Baya but, as there was no record of this species nesting in reeds, a mistake was suspected.

On 19th October HA returned to the place and saw at least two nests being attended to by birds in 'Female' plumage which appeared to be Common Bayas, but was unable to see or obtain any accompanying male in breeding plumage.

A third attempt was made about midday on 20th October by HA with the late Mr. D. E. Reuben on the way back from the opening of the Karnala Bird Sanctuary. Though there were bayas in the vicinity, none of them appeared to be interested in the nests and yet another visit was indicated at some other time of day.

On 6th November the place was visited again (with V.C.A.) intending to leave him there for a longer period if the owners could not be immediately identified. We got there about 7 a.m. Though we waited for some time, no weaver birds came near the nests and all the grass of which the nests were made had dried up making it fairly certain that work had been discontinued. V.C.A. was quite certain that they could only have been made by the Common Baya. The nests were between ten and fourteen inches in length and two or three of them had been made as far as the bar, with no egg chamber even commenced. Most of them had bits of mud plastered on to the inner wall above the level of the bar.

It has now been accepted for some time that in the Common Baya, it is the male alone in breeding plumage that builds the nest, with the female only helping a little in the final stages. Young males are known to build 'doodling' nests (Sálim Ali JBNHS 34: 953). It is possible that the birds seen building were young males which were 'practising' among the reeds, presumably not acquiring a breeding plumage during the current season. Their breeding in reeds does not appear to have been recorded so far. If our conjecture is correct, this behaviour of immature birds possibly suggests that the species was originally a reed-builder ?

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14. FIRST INDIAN RECORD OF CHAFFINCH (*FRINGILLA COELEBS*)

During the afternoon of 4th December 1982 a female Chaffinch (*Fringilla coelebs*) was watched by a party of British Birdwatchers on a visit to the Corbett National Park in Uttar Pradesh.

I first spotted the bird as it was mobbing a

Jungle Owlet *Glaucidium radiatum* which was perched completely in the open on the outside of a tree at the forest edge not far from the Park Headquarters. We watched the bird for several minutes through telescopes mounted on tripods and there can be no doubt as to its identity as it is a very familiar species with us in England, even in our gardens. Because of this familiarity, most of the party preferred to watch the owlet, which was of course a new species for them!

The bird was about the size and general shape of a female House Sparrow *Passer domesticus* but rather longer-tailed. The upperparts were dull brown with a greyer tinge to the head and the underparts became whiter from the lower breast down to the under tail-coverts. There was no supercilium, the rather plain head being relieved by a slightly darker shade which ran either side of the rear of the crown down the sides of the nape. The wings were darker than the mantle and had two very conspicuous white bands, a broad band of white on the median coverts and a narrower one formed by tips of the greater coverts. As it moved about the tree mobbing the Owlet the conspicuous white outer tail feathers and greenish tinge to the rump were noted and the crown feathers were raised to form a marked peak at the rear of the head. The greyish bill was markedly pointed and quite conical and the legs were greyish pink.

The occurrence of this species in Northern India in winter is hardly surprising as it is quite a frequent winter visitor to Afghanistan (where I have also seen it) and according to Ripley (1982) and Fleming *et al.* (1979) it is an occasional winter visitor to northern Pakistan and north-western Nepal. The most surprising thing being perhaps that it hasn't been picked up in winter in the Indian Himalayan foothills before.

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15. ADDITIONS TO THE BIRD SPECIES RECORDED FROM NEPAL

The following account provides data on bird species recorded from Nepal but which are not included in R. L. Fleming *et al.* (1979).

The nomenclature mainly follows Voous (1977) which is becoming widely used as a standard work for the names of Palaearctic species. It forms the basis of a work currently being prepared on the distribution of birds in Nepal (C. and T. P. Inskipp *in prep.*). Differences from the nomenclature used by Ali and Ripley (1968-74) and Ripley (1982) are indicated.

Great care has been taken to assess the accuracy of all sight records included here. Full field notes of such records have been provided. One or two species have been omitted as details were not considered adequate. There are also two species, Red Spurfowl *Galloperdix spadicea* and Isabelline Shrike *Lanius isabellinus* (= *Lanius collurio isabellinus*) which were included for Nepal by Ripley (1982) but we have not so far been able to discover the source of these statements.

FULVOUS WHISTLING DUCK (= Large Whistling Teal) *Dendrocygna bicolor.* Sharpe (1894) refers to a specimen collected in Nepal by B. H. Hodgson. Confirming this, an undated specimen collected by Hodgson in Nepal was located in the collection of the British Museum (Natural History) in 1981.

BAER'S POCHARD *Aythya baeri.* Observations of two males and one female were made at Kosi Barrage in the eastern terai (altitude 75 m) on 12 February, 1979 and 17 males and three females on 20 February, 1979 by R. Filby, R. Grimmett, F. Lambert, C. Murphy, L. Norton and N. J. Redman (Lambert 1979, Redman *et al., in press*).

LONG-TAILED DUCK *Clangula hyemalis.* An immature male was observed at Kosi Barrage from 13 to 15 March, 1981 by T. P. and C. Inskipp (1981).

SAKER FALCON *Falco cherrug milvipes* (= *Falco biarmicus milvipes*). Specimens were collected in Nepal by B. H. Hodgson (Gray & Gray 1846). Manuscript notes on Hodgson's unpublished paintings indicate that three specimens were collected in the Kathmandu Valley on 1 and 11 November and 12 December. No year is given. It is listed for Nepal by Ali and Ripley (1972).

BARBARY FALCON *Falco pelegrinoides babylonicus* (= *Falco peregrinus babylonicus*). Listed as collected in Nepal by B. H. Hodgson (Sharpe 1874). However during a recent examination of specimens at the British Museum (Natural History) none which was unequivocally *F. pelegrinoides* could be located. Several birds were observed at Kagbeni and Tangbe, Thakkhola, altitude 3-3200 m in late July 1977, September and early October 1978 by J. M. Thiollay (1978).

SANDERLING *Calidris alpina.* A single bird was observed at Kosi Barrage on 11 February, 1979 by R. Filby, R. Grimmett, F. Lambert, C. Murphy, L. Norton, and N. J. Redman (Lambert 1979, Redman *et al. in press*).

* CURLEW SANDPIPER *Calidris ferruginea.* An adult in breeding plumage was seen at Kosi Barrage on 22 April, 1981 by M Hendrikson, N. Krabbe and O. Lou (Krabbe 1981).

TEREK SANDPIPER *Xenus cinereus* (= *Tringa terek*). One was seen at Kosi Barrage on 18 April, 1982 by J. Eames and R. Grimmett. (Eames 1982, Grimmett 1982).

COMMON GULL *Larus canus.* A first year bird was seen at Kosi Barrage on 12 February, 1979 by R. Filby, R. Grimmett, F. Lambert, C. Murphy, L. Norton and N. J. Redman. It was still present on 21 February 1979. (Redman *et al., in press*). No previous published records for the Indian sub-continent.

LESSER BLACK-BACKED GULL *Larus fuscus.* An adult was observed at Kosi Barrage on 13 April, 1981 by D. Mills and N. Preston (1981).

WHITE-WINGED BLACK TERN *Chlidonias leucopterus.* A bird in breeding plumage was observed at Phewa Tal, Pokhara, west-central Nepal, (altitude 900 m), on 4 May, 1981 by M. Henriksen, N. Krabbe and O. Lou. (Krabbe 1981).

LITTLE OWL *Athene noctua.* Collected in the Dolpo at Terco Phijar on 8 July, 1978 and at Tnku, Do, Trap on 23 July, 1978 by H. S. Nepali (*pers. comm.* 1982).

WHITE-VENTED SPINETAIL SWIFT *Hirundapus*

cochinchinensis rupchandi (= *Chaetura caudacuta rupchandi*). Collected by W. Koelz at Hitaura, central upper tarai on 24 June, 1947 (Biswas 1951).

ASIATIC HOUSE MARTIN *Delichon dasypus cashmiriensis* (= *Delichon urbica cashmiriensis*). Listed for Nepal by Ali & Ripley (1972). First definitely recorded by Diesselhorst (1968) from Periche in the Khumbu (altitude *c.* 4250 m) on 27 August, 1962. Specimen obtained.

TAWNY PIPIT *Anthus campestris.* Collected on 22 August, 1898 by E. Arigoni. This specimen was included in the O. V. Aplin Collection 1940 and was located in 1982 in the collection of the Oxford University Museum.

FOREST WAGTAIL *Dendronanthus indicus* (= *Motacilla indica*). Recorded at Royal Chitwan National Park in the central duns (altitude 75 m) on 30 November, 1979 by K. Curry-Lindahl (1980).

RUFOUS-TAILED THRUSH (=Dusky Thrush) *Turdus naumanni.* Ali & Ripley (1973) state central Nepal (large flocks in winter and spring — Proud, *J. Bombay nat. Hist. Soc.* 48: 703). This is predated by specimens collected by B. H. Hodgson (Gray & Gray 1846). Manuscript notes on Hodgson's unpublished paintings indicate that two specimens were collected in the Kathmandu Valley on 10 and 29 January (year not given).

MOUNTAIN TAILORBIRD (= Goldenheaded Tailor-Bird). *Orthotomus cuculatus.* Ali & Ripley (1973) state 'Eastern Nepal not recorded since Hodgson'. However it is not listed in the catalogues of Hodgson's collections (Gray & Gray 1846, Gray 1863). An undated Nepal specimen without a collector's name was located in the collection of the British Museum (Natural History) in 1981.

EASTERN GRASSHOPPER WARBLER *Locustella naevia straminea.* One was ringed at Kosi Barrage on 11 April, 1976 by R. C. Gregory-Smith (Gregory-Smith & Batson 1976).

BLACK-BROWED REED WARBLER *Acrocephalus bistrigiceps.* A single bird was observed at Kosi Tappu (altitude *c.* 75 m), on 19 January, 1981 by J. Hall (1981).

RADDE'S WARBLER *Phylloscopus schwarzi.* A bird was observed at Charali (altitude *c.* 75 m) in the eastern terai on 25 December, 1979 by R. Fairbank (1979). No previous published records for the Indian subcontinent.

RED-HEADED PARROTBILL (= Greater Redheaded Parrotbill) *Paradoxornis ruficeps.* A specimen collected in Nepal by B. H. Hodgson is referred to by Horsfield & Moore (1854). An undated specimen from the Seebohm collection, presumably collected by Hodgson, was located in the collection of the British Museum (Natural History) in 1981.

SPANISH SPARROW *Passer hispaniolensis.* A flock of about 50 birds was observed at Kosi Barrage on 16 February, 1981 by T. Baker, D. Mills and N. Preston (Baker 1981, Mills & Preston 1981).

EURASIAN SISKIN *Carduelis spinus.* A male was identified at Nagarjung (altitude *c.* 1500 m) in the Kathmandu Valley on 7 April, 1982 by C. Winyard (*pers comm.* 1982) and later seen by R. Fairbank, D. Mills and N. Preston. First published record for the Indian subcontinent by Gaston and Chattopadhyaya (1981).

YELLOWHAMMER *Emberiza citrinella.* An adult male was observed at Kagbeni (altitude *c.* 2940 m) in west central Nepal on 25 February, 1981 by T. Baker, D. Mills and N. Preston (Baker 1981, Mills & Preston 1981).

No previous published records for the Indian subcontinent.

RUSTIC BUNTING *Emberiza rustica.* A male was seen at Sauraha (altitude *c.* 75 m) near the Royal Chitwan National Park on 31 January, 1981 by P. Ewins and A. del Nevo (del

Nevo & Ewins and A. del Nevo (del Nevo & Ewins 1981).

No previous published records for the Indian subcontinent.

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16. OBSERVATIONS ON *GEOCHELONE ELEGANS* (SCHOEPFF) IN CAPTIVITY, ORISSA, INDIA

Four adult Star Tortoises, *Geochelone elegans* (Schoepff) were obtained from a collector of the Park and kept for a minimum of three years in the Nandankanan Biological Park, Orissa, India, for captive breeding (see Table 1). All three females died during winter, and although the cause of death was not determined, all females were reproductively active. One animal laid 4 eggs which ranged from 37 to 41 mm in length, 29 to 34 mm in breadth and 21.3 to 24.5 mm in height.

These observations show that females as small as 21.0 cm (straight line) carapace length can reproduce. They also show that, at least in Orissa, nesting can occur from October through January. This is consistent with Hutton's report (in Smith, 1931: 139) of a captive nesting in November with 4 eggs. In contrast Deraniyagala (1930) recorded captive nesting in June and October in Sri Lanka. The egg dimensions reported here are comparable to those described by Deraniyagala but smaller than those reported by Smith (1931).

The fact that the females died while reproductively active suggests that they incur increased risks between vitilization and oviposition. It is known in other turtles that non-viable eggs may not be laid (Ewert 1979), and egg-bound females frequently die due to difficulty in oviposition.

TABLE 1

MEASUREMENTS (IN STRAIGHT LINE DISTANCES IN CM) AND OBSERVATIONS ON CAPTIVE *Geochelone elegans* IN NANDANKANAN BIOLOGICAL PARK

No.	1	2	3	4
Sex	27.5	22.5	21.0	26.5
Carapace length	20.0	14.0	13.0	16.5
Carapace width	13.0	10.5	12.0	—
Body depth	24.0	18.5	17.0	22.5
Plastron length	17.0	14.0	11.0	15.5
Plastron width	3.020	1.530	1.100	1.200
Weight (kg)		(14.i.1982)	(xii.1980)	(3.x.1981)
Date died		enlarged	6 shelled,	laid 4 eggs
Remarks		follicles	oviducal eggs	

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17. *EUBLEPHARIS HARDWICKII* (REPTILIA, GEKKONIDAE), THE KALAKUTA, OBSERVED AT TIKERPADA, ORISSA

(*With a photograph*)

The Common Fat-tailed Gecko, *Eublepharis macularius* is relatively better known and described (Smith 1935, Daniel 1983) than its ally *Eublepharis hardwickii* for which Smith emphasized a highly circumscribed range of distribution and mentioned that nothing has been recorded on the species' habits. Smith (1935) wrote: "It is definitely known from Chota Nagpur and Orissa and the adjacent districts of Bengal, the Madras Presidency, the Central and United Provinces...".

In the Satkoshia Gorge Sanctuary of Orissa, *Eublepharis hardwickii* is not uncommon at Tikerpada, a village at the foot of hills rang-

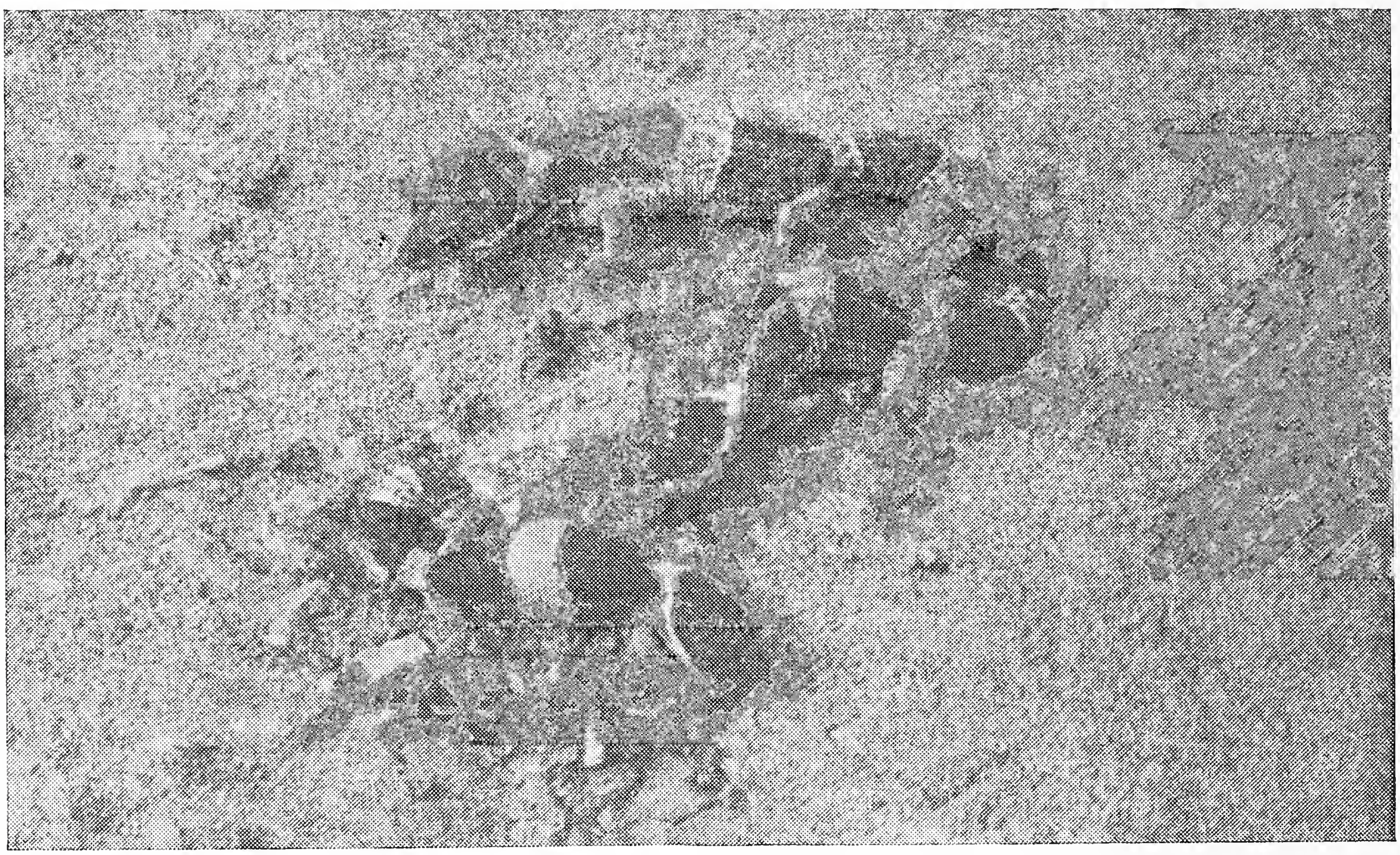

Photo. 1. *Eublepharis hardwickii.*

ing up to 600 m on the bank of the River Mahanadi. In the night, during summer and rains, these may be found on the forest roads or on open areas, and in the day several individuals have been recovered from underneath rocks and stones.

The body coloration varies from reddish brown to very dark brown (as stated by Smith 1935) to almost black. The transverse markings are cream-coloured to light yellow. The transverse markings on the tail are dull whitish. During a period of about six years several of these geckoes were received at the Gharial Research and Conservation Unit, Tikerpada. All these were accidentally caught and none exceeded 20 cm.

In captivity *E. hardwickii* is very timid, allowing to be lifted by hand and accepting a variety of insects as diet. Attempts to catch a prey was incited only by the victim's body movement. At least one definite case of cannibalism was recorded in captivity — mode of capture was from the neck and during swallowing the victim lay with its ventral side up. *E. hardwickii* never took water from a container in captivity; instead, they used to wait for an artificial shower to lick off drops falling on their head or sticking to the surfaces on the surroundings. The tongue is pinkish red, flat, thin and able to extend over to the eyes and head. One or two leathery eggs (approx. 20 × 10 mm) are laid and buried in soil.

Eublepharis hardwickii is called the *Kálakuta Sapa* in Orissa (Oriya: *Kálakuta* = one which brings the message of death, and *Sápa* = snake). The local name originates from the belief that these geckoes are highly poisonous, can climb trees (which these can) and after a bite the higher they climb the effect of the poison gets gradually intensified. The gecko makes a shrill vibrating noise when surprised.

ACKNOWLEDGEMENTS

Orissa Forest Department provided scope for observing the '*Kálakuta*' in the sanctuary, Dr. H. R. Bustard gave all encouragement; Zoological Survey of India, Calcutta identified a specimen, and the staff at Tikerpada assisted in obtaining and maintaining the geckoes in captivity.

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18. OCCURRENCE OF FLYING LIZARD (*DRACO DUSSUMIERI*) IN THE NILGIRIS

The distribution of the Southern Flying Lizard in the subcontinent has been recorded by J. C. Daniel (1983 THE BOOK OF INDIAN REPTILES P. 46). Its occurrence in Mundanthurai Sanctuary, South Tamil Nadu was recorded by Mangalraj Johnson (*JBNHS* 80, pp. 229-230). The habitat of the *Draco* according to Daniel is evergreen biotopes, arecanut, coconut and betel vine plantations in the plains. Mangalraj reported them in plantations of teak, neem and bamboo in Mundanthurai. I would like to add the Coffee/Cardamom plantations also to their habitat. They are commonly seen on Silver Oak (*Grevillea robusta*), and Indian Coral trees (*Erythrina indica*) of coffee plantations in one of the estates on the southern slope of Nilgiris. When I stayed in one of the old Bungalows of the Pilloor group of estates in 1978 I have seen the *Draco* on the eave of the roof of this building. The bungalow is situated at an altitude of 1292 m MSL. This increases the altitudinal distributional range of this lizard up to 1292 m from 1000 m (3250 ft).

All the three specimens whose stomach contents I examined had white, and red ants. One stomach had in addition the remnants of a fly and another the mouth parts of a small beetle and a few small black ants. During my Western Ghats survey I have recorded this species from Silent Valley, Nilambur forests, Valar forest, Parambikulam, Thattakadu, Idikki, Periyar Tiger Reserve, Sabaramali Forests etc. from South. During 1980 when I visited Coorg I saw a specimen in one of the coffee estates at Sidhapuram near Mercara.

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19. A NOTE ON THE ASIATIC ROCK PYTHON (*PYTHON MOLURUS*) FEEDING ON THE SPOTBILL DUCK (*ANAS POECILORHYNCHA*)

On the early hours of 22nd May 1984, we were cycling down one of the dykes intersecting the marshes of Keoladeo National Park in Bharatpur, Rajasthan in search of nests of resident ducks. We examined all the *Acacia* planted mounds near the dyke and were lucky to see a Python capturing and devouring a Spotbill duck.

The snake must have been waiting coiled up on the mound, as it caught the duck entirely unawares. Soon after the capture the massive snake took to the water, and all that could be seen for a few moments was the tail half thrashing about above the water surface. Distressed over the loss of its mate, another Spotbill which was seated nearby incessently kept uttering a series of alarm calls. All the herons and egrets perched on the trees around

silently witnessed the struggle between the duck and the snake. It took approximately an hour for the Python to swallow its prey, after which it disappeared into the grass covered, waters.

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B. RAM MANOHAR

20. A COUCAL-PYTHON INCIDENT

On the morning of 27th April 1984, at about 7.30 a.m., we were walking down the metal topped road running across the Keoladeo National Park at Bharatpur, Rajasthan. On both sides stratched the vast grassy wetlands dotted here and there with planted acacia trees. Suddenly one of us saw a black creature thrashing about in the midst of the marsh about 50 feet away from the road. We were puzzled to see a ring of about 20 Egrets and Pond Herons watching the creature, which was apparently in great distress. On closer examination, it turned out to be a coucal *Centropus sinensis* (Stephens) being strangled by a young Python *Python molurus* (Linnaeus) about 125 cm long.

For the next two hours we observed the one-sided battle between the reptile and the bird. The snake tried its best to swallow the bird but, being a young one, all its efforts were in vain. From a distance of a few feet away, we observed the python widening its gape now and then to the utmost extent, yet the prey could not be swallowed. At one stage, it indeed appeared that the bird would be injected but the bill acted as a hindrance.

At the very beginning the coucal showed signs of life but eventually, it died due to the relentless strangling. The snake coiled itself around the bird and squeezed it to such an extent that the normally stout bird looked slender.

Finally at 10 a.m. the python let go its prey and disappeared into the water. Obviously the coucal was too large for it to tackle.

ACKNOWLEDGEMENT

I am thankful to Dr. V. S. Vijayan, Project Scientist.

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21. PROTECTIVE METHODS FOR SNAKES FROM EXTERNAL INFECTION OF MITES

Snakes are sometimes attacked by mites in nature as seen on rat snakes, *Ptyas mucosus* collected from nature for the study of their behaviour, breeding and biology. Snakes are usually free from parasites.

Sometimes, a few showed the presence of either larvae of mites or adult, or both as ectoparasites on the body. If such infected specimens are kept with other snakes, the mites are transmitted to one another. These mites carry micro-organisms which may produce fatal diseases. As the mites are able to travel from one vivaria to another, it is necessary to examine freshly caught snakes for mite infection. In case a snake is found to be infected with mites it should be segregated and treated.

The preliminary sign of infection is the presence of whitish deposits of mite feces on the body scales of the snake. If the snakes are then carefully examined, the presence of mites of 1.00 ± 0.25 mm size can be seen as black dots on the body. The young mites can be seen as the moving dust particles on the scales of the snakes. Acute mite infection is fatal for the snake.

The following treatments and precautions are used to keep the snakes mite-free in the serpentarium.

i) Fresh caught snakes should be very carefully examined for mite infection as ectoparasite before being added to the serpentarium.
ii) Infected snakes should be immediately segregated.
iii) Infected snakes and cages should be thoroughly cleaned.
iv) Infected snakes should be bathed several times in a tub containing gentle warm water and then wiped up with soft cotton cloth.
v) All the mites should be removed from the water before immersion of another infected snake.
vi) Infected cage should be washed with boiling water to kill the mites and their young.
vii) During the cleaning of the infected snakes and cages, care should be taken not to allow the mites to spread in the serpentarium.
viii) In segregated and separated snakes vivarium strips of "Anti mite Vapona insectide" should be hung. With the help of this insecticide strips these mites disappear from the cages in couple of days.
ix) Vapona insecticide can be bought from Shellster Limited, 70, Brompton Road, London, SW3, England.
x) DDT is not to be used for spraying.

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22. OCCURRENCE OF *PLEUROXUS SIMILIS* VAVRA (CLADOCERA: CRUSTACEA) IN INDIA

During a study of the Cladocera fauna of Madhya Pradesh I came across six female specimens of *Pleuroxus similis* Vavra which were sorted out from the small zooplankton sample collected by my colleague, Sri P. L. Kankane from Deshi Nala, Kanha National Park, Mandla district, Madhya Pradesh, in April 1977. Existing records show that this species is so far recorded from Australia; Valdivia (Chile); Northern Caucasus lake, Tashkent in the U.S.S.R., and Sri Lanka. The present find therefore extends its known range of distribution to Central India.

Pleuroxus similis Vavra, 1900

FEMALE. The specimens studied agree well with the description by Smirnov (1971) which is briefly reads: Dorsal margin uniformly convex. Posterior margin almost straight. Maximum height 3-4 times length of posterior margin. Rostrum pointed, reaching leval of ventral margin of the valve. Valve with no pattern. Ventral margin of the valve with three rather blunt denticles. Antennules ending far before apex of rostrum. Post-abdomen slightly tapering. Dorsal distal corner of post-abdomen situated slightly behind base of claws. Preanal corner blunt, there are 13-14 anal denticles. Claw with two basal spines, first is about half the length of second. Colour of the specimens shows variation from yellow to dark brown. Intestine with loops and with caecum. Distance of ocellus to eye half its distance to apex of rostrum. (Length range: 0.37 mm-0.45 mm)

I thank Dr. K. Raddiah, Deputy Director of this station, for his keen interest, encouragement and for going through the manuscript, and Sri P. L. Kankane making this interesting collection available to me.

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23. NEW RECORDS OF *GRIMALDINA BRAZZAI* RICHARD AND *BOSMINOPSIS DEITERSI* RICHARD (CRUSTACEA: CLADOCERA) FROM INDIA

During the course of Cladocera Survey in Madhya Pradesh I collected some specimens of *Grimaldina brazzai* Richard and *Bosminopsis deitersi* Richard, from tanks of Jabalpur, which constitute a new record from India. The presence of these species in India

is quite interesting because the first was hitherto known only from Sri Lanka (Fernando 1974), America (Brooks 1959) and West Africa whereas the second was reported only from Sri Lanka and America. Thus the distribution of these species has been extended to Central India.

1) *Grimaldina brazzai* Richard, 1892

This sole species of the genus can be easily isolated from others in having a very large compressed post-abdomen, with a long spine-bearing notch. The other characters in brief are as follows :

Body compressed, somewhat quandrangular, with all margins of the valve slightly convex. A notch divides the preanal portion into two parts, of which the anterior is smaller. A long spine in the notch marks the junction of anal and preanal portions of the postabdomen. There are two lateral rows of small slender spines on the anal part, about 7 in anterior and 5 in posterior row. Claw small, denticulate with one small basal spine. Antennules with two basal sense hairs in female.

Material — 7 specimens, Budhager tank, *c.* 22 kms. North of Jabalpur on Sihora Road, Jabalpur distt., Madhya Pradesh, 18.iv.81, length, female — 1 mm.

The specimens were collected with other Cladocera like *Chydoras sphaericus, Ceriodaphnia* sp. and *Simocephalus* spp. At the time of collection the tank was completely covered with cultivated vegetation, mostly *Trapa bispinosa* Roxb.

2) *Bosminopsis deitersi* Richard, 1895

This species is much like its closely related *Bosmina* sp., but the main difference is that the basal parts of the antennules are united with each other and to the head to form a very long rostrum, diverging laterally near the apex, with long, straggling, olfactory setae. The inferopostal corner of valve with two (one small and one large) teeth is also one of the main differentiating characters. The species closely resembles the original description but differs in the valve character which is prolonged at the posterodorsal angle to form a tooth-like projection.

Material — 5 specimens, Pariat tank, *c.* 30 kms. east of Jabalpur on Amarkantak Road, Jabalpur distt., Madhya Pradesh 10.xii.1980, length — 0.3 to 0.35 mm.

The water of the tank was green due to the predominance of floating flora *viz.*, *Volvox, Euglena* and rooted plants. The associated Cladoceran species includes *Scapholeberis* sp. and *Diphanosoma* spp.

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24. HYDROLOGY OF A LENTIC WATER BODY AND ITS SIGNIFICANCE IN PLANKTON PRODUCTION

(*With a text-figure*)

The paper describes the seasonal variation of physico-chemical factors of Undasa Pond (Madhya Pradesh) for one year from January to December 1978. The surface water was found always alkaline, with pH ranging from 7.6 to 8.1. Dissolved oxygen varied from 4.0 to 8.4 mg/L in March. Very low transparency was found in monsoon season (July to September). Free carbondioxide in surface water was recorded during July, August and September. An interrelationship with pH, dissolved oxygen, alkalinity with total volume of plankton was also recorded. The high alkalinity and low visibility indicate eutrophic nature of the pond. The high chloride content may be due to animal pollution.

INTRODUCTION

Undasa Pond is used mainly for irrigation. However pisciculture is also undertaken in it by Madhya Pradesh Government Fisheries Department. The pond has an area of 212 hectares. It is situated in Undasa village about 4-5 km from Ujjain at Ujjain-Makshi Road. An embankment has been constructed around the three sides of the pond to store water in rainy season. The pond is perennial.

MATERIAL AND METHODS

The study of physico-chemical factors and total plankton volume was made on every 15th of the month for 1978. The temperature of surface water was measured by 110°C graduated thermometer and transparency by Secchi's disc. pH was determined by narrow range pH paper and B.D.H. universal indicator in the field and by pH meter (systronix — 322) in the laboratory. Dissolved oxygen was estimated by unmodified winkler's method and free CO_2 was determined by method given by Welch (1952). Carbonate, bicarbonate, inorganic phosphate, nitrate-nitrogen and chloride were estimated by standard methods (American Public Health Association 1955). Surface water from a definite place and depth was always used for above analysis. Plankton volume was noted by filtering 100 litres surface water through plankton net of bolting silk No. 20 and after settling in graduated test tube, all samples were analysed within an hour of collection.

RESULT AND DISCUSSION

The summary of the observations is given in Table 1 and Fig. 1.

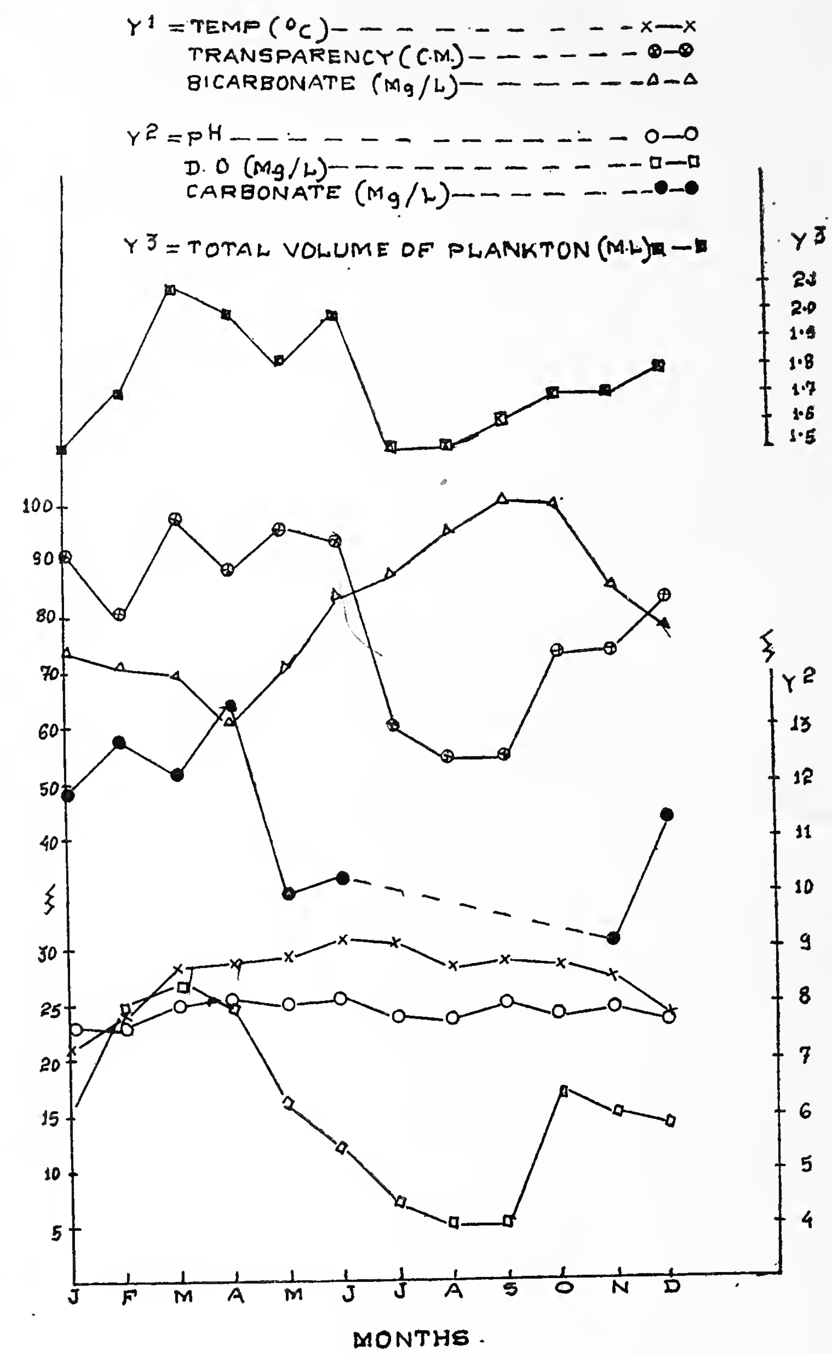
Temperature. This is one of the most important hydrobiological factors related to fish production (Das & Pathani 1978). Surface water temperature of Undasa Pond revealed that there was seasonal variation. The temperature was found to increase from January to June when highest temperature was recorded. The temperature dropped from June to December with exception in September. The decrease in temperature in July and August was most probably due to cloudy atmosphere and rain. The heavy influx of rain water from neighbouring areas may be another reason for low temperature. The lowest temperature was recorded in January. The monthly water tem-

TABLE 1

MONTHWISE VALUE OF PHYSICO-CHEMICAL AND BIOLOGICAL CHARACTERISTICS OF UNDASA POND DURING 1978.

Months	Physical characteristics			Chemical characteristics							
	Water temp. (°C.)	Transparency (cm)	pH	Dissolved oxygen (mg/L)	Carbonate (mg/L)	Biocarbonate (mg/L)	Free carbon-dioxide (mg/L)	Chloride (mg/L)	Phosphate inorganic (mg/L)	Nitrate Nitrogen (mg/L)	Value* (Plankton)
January	21.0	91.3	7.6	6.0	11.8	73.6	—	8.3	0.08	0.04	1.5
February	24.0	79.9	7.8	8.0	12.7	70.8	—	8.3	0.079	0.035	1.7
March	28.3	98.0	8.0	8.4	12.1	70.3	—	8.8	0.075	0.03	2.1
April	29.0	88.0	8.1	8.0	13.4	60.3	—	8.5	0.08	0.03	2.0
May	29.3	96.0	8.0	6.2	10.0	70.1	—	9.3	0.12	0.04	1.8
June	31.0	93.5	8.1	5.4	10.3	83.5	—	8.7	0.08	0.03	2.0
July	30.6	59.6	7.8	4.4	—	87.3	2.0	8.1	0.10	0.08	1.5
August	28.7	54.0	7.7	4.0	—	96.0	2.5	8.1	0.07	0.08	1.5
September	28.9	54.5	8.0	4.0	—	100.7	2.4	8.0	0.08	0.06	1.6
October	28.4	73.0	7.8	6.4	—	100.0	2.5	8.3	0.10	0.035	1.7
November	27.5	73.4	7.9	6.0	9.1	85.0	—	8.4	0.08	0.035	1.7
December	24.8	83.0	7.7	5.8	11.3	78.3	—	8.3	0.08	0.04	1.8

* Value ML/100 litres



(Fig. 1)

perature in the pond changes alongwith the change in air temperature (Oppenheimer *et al.* 1978). The temperature difference between lowest and the highest was noted as 10°C in Undasa Pond while Srivastava *et al.* (1979) noted it as 10.2°C in a Govindgarh lake, Rewa.

Transparency. Seasonal changes in transparency were quite apparent (Table 1). The transparency of a pond depends upon the

turbidity of water (Hitchinson 1957), which is caused by silting, micro-organisms and suspended organic matters in the water (Khan & Siddiqui 1974). The Secchi's disc readings have usually been converted into the depth at which 1% light was present (Strickland 1958, Riley 1941, Norden 1968). In present study visibility values varied from 54 cm to 98 cm. Thus euphotic depth of Undasa Pond appears to be from 135 cm to 228.25 cm (conversion factor = 2.5 as followed by Khan & Siddiqui 1974). This indicates that production is only limited to a narrow upper belt of water while rest of the depth is consuming and unproductive. The low transparency noted in rainy season which may be attributed to colloidal mud particles brought about by in coming water and to increased depth of water. Ganapati (1962) reported transparency variation from 50 cm to 120 cm in Red hill reservoir, Tamil Nadu. George (1976) found transparency variation from 47.4 cm to 85.5 cm in Lower Lake, Bhopal and attributed to low transparency during summer monsoon due to degeneration of blue-green algae which reduce the light penetration. Khan & Siddiqui (1974) reported transparency variation from 33.7 cm to 56.3 cm in a perennial fish pond in Aligarh. Disappearance of Secchi's disc throughout the year in Undasa Pond demonstrates the degree of eutrophication occurring in the pond. The pond receives rain water from the catchment area which carries effluents, inorganic compounds and particulate matters in the pond which have converted the pond to an eutrophic condition. Similar eutrophic condition was noticed in Nainital Lake by Das & Pathani (1978).

H-ion concentration. The pH of lake water has an important bearing on both plankton and fish production (Das 1961). The pH of surface water of the pond was found within alkaline range (7.6-8.1). The high pH during March, April, May, June and September may be due to high photosynthetic activity. Das & Srivastava (1956) and Sreenivasan (1963) found that a pH of 7.2-8.5 is only favourable for the growth of plankton although the best is 7.2-8.0. Thus the pH of Undasa Pond is suitable for plankton and fish production. Swarup & Singh (1979) reported pH variation from 7.4-8.9 in a Suraha Lake. Clearcut increase in pH of Undasa Pond was noticed from January to April while thereafter the pattern was irregular.

Dissolved Oxygen. From the investigations in the Undasa Pond it was found that dissolved oxygen increased from January to March and may be attributed to low temperature and high photosynthetic activity. During monsoon oxygen concentration was very low because of influx of turbid drainage water, low phytoplankton population and partly due to increased respiration caused by organic matter accompanying the drainage water (Khan & Siddiqui 1974). The highest dissolved oxygen content was recorded in March. The low oxygen content during May and June may be due to low water level, high temperature and death and decay of macrovegetation. Ellis (1946) also stated that the respiratory activity of animals dwelling in the area and decay of dead organic substances are the chief causes of under saturation and depletion of oxygen in tropical waters.

Carbonate, bicarbonate and free carbondioxide. The increased quantity of carbonate alkalinity during cold weather (January to April) showed photosynthetic activity while decrease in bicarbonate in Undasa Pond during cold weather may be due to its absorption by phytoplankton and aquatic macrovegetation. An inverse correlation between carbonate alkalinity and bicarbonate alkalinity was found in

Undasa Pond. The carbonate value was absent during July, August, September and October when free CO_2 in surface water was present. This may again be attributed to low photosynthesis. Jana (1974) found total absence of carbonate alkalinity for a major part of the year in a pond at Santiniketan while Ganapati (1962) found that surface water in Red hill reservoir contained carbonate alkalinity throughout the year. The high value of total alkalinity may be due to pollution, abundance of macrovegetation, and organic materials entering into the pond with rain water. Das & Akhtar (1970) found that increase in alkalinity is due to pollution, decrease in water level and seepage.

Chloride. High chloride content was present all the year round. The high chloride content is indicative of pollution derived from animals which regularly visit the water. George (1976) reported influx of drainage water and temperature controlling the chloride content in the Lower Lake of Bhopal.

Inorganic phosphate and nitrate-nitrogen. Both the values were in traces only. In Undasa Pond phosphate and nitrate were highest during the monsoons which may be due to rain washings, destruction of cell protoplasm by bacteria and destruction of agencies consuming the nutrients, Poor phosphate and nitrates were also recorded by Mathew (1975) in a Govindgarh lake. Ghosh *et al.* (1974) recorded high phosphate and nitrate in sewage-fed fish pond and Sreenivasan (1972) recorded extremely high value of PO^4-P up to 22 ppm in Vellore Moat. However according to Hora & Pillai (1962, 114) the highest plankton production which in turn allows for maximum fish production occurs when the water contains 4 ppm of nitrogen with 1 ppm of phosphorus and 1 ppm of potassium.

Correlation of various physico-chemical factors with total volume of plankton

An interrelationship was observed among pH, oxygen, carbonate, bicarbonate alkalinity and plankton volume in the present study of Undasa Pond (Fig. 1). The pH increased gradually from January to April and then declined until minimum was reached in August. The dissolved oxygen content showed increase from January to March and then decreased till August-September. The carbonate alkalinity also showed similar pattern and bicarbonate indicated a reverse relationship with all the three parameters (Fig. 1). The total volume of plankton was directly related to pH, dissolved oxygen and carbonate alkalinity and inversely related to bicarbonate content. The water was always alkaline. Sreenivasan (1963) reported that pH of 7.2 to 8.5 is only favourable for plankton growth. The pH of Undasa Pond is between above range. No distinct relationship among total volume of plankton, phosphate and nitrate was noted. Prescott (1939) stated that phosphorus correlated with plankton productivity, whereas Juday & Birage (1931) found evidence of phosphorus as limiting factor in phytoplankton growth. Saha *et al.* (1971) also observed that nitrate and phosphate are not always correlated with plankton growth.

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25. A NEW RECORD OF *PYEMOTES* SP. (PEDICULOIDES) OF MITE PARASITIZING THE COMMON INDIAN HOUSE FLY — *MUSCA DOMESTICA NEBULO* FABR.

(*With a text-figure*)

Dhiman (1981) reported for the first time a mite, *Microtrombidium* sp. parasitizing the house fly. During the collection of house flies for recording the data of infestation of this species of mite, we came across another species of mite, *Pyemotes* sp. (Acarina-Pyemotidae) also parasitizing the house flies in good number. This is an extremely small mite being 0.12 ± 0.05 mm in length and 0.05 ± 0.02 mm in width. The body is elongated and yellowish white in colour. Gnathosoma is conspicuous and retractable. Chelicerae and padipalps are minute in size. Palpi are closely appressed to rostrum. Body setae well developed, six pairs of dorsal setae and four pairs of ventral setae. Coxal apodemes are obvious. A club shaped hair is present posterior to the base of first leg on each side. A few tarsal setae are considerably long than others, specially of first and 3rd leg. Claws well developed and curved. Claws of fore leg stouter and shorter in size. A membranous empodium is present in between the claws of second to fourth legs. A pair of small eyes are present, each one on lateral sides of dorsum (scutum) (Fig. 1).

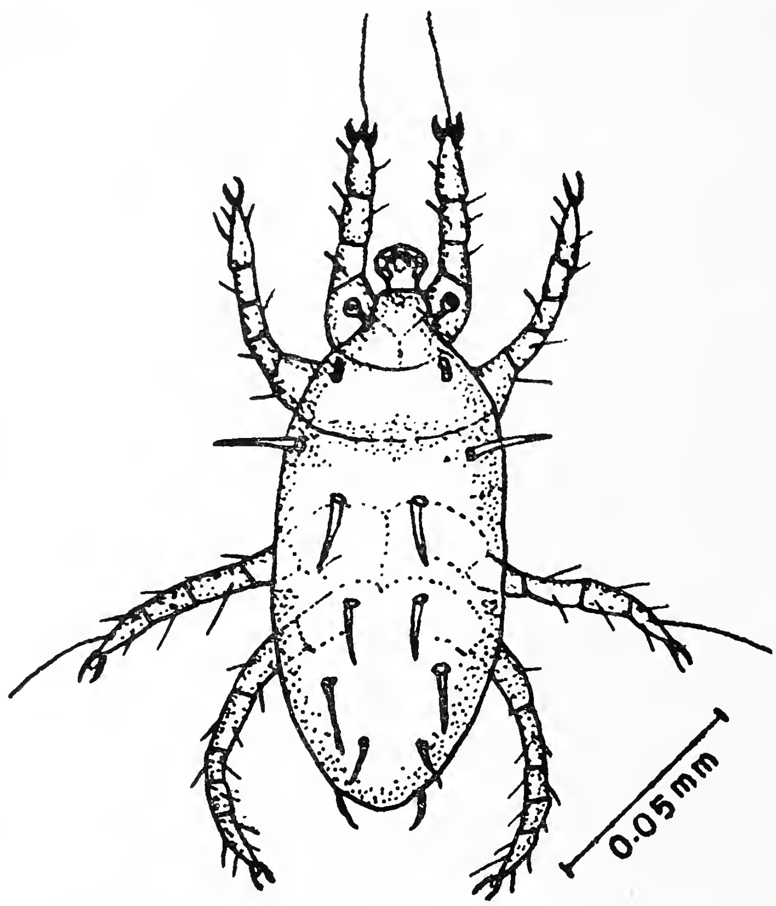

Fig. 1. Dorsal view of the *Pyemotes* sp. of mite.

The mite parasitizes the house fly from March to October which are the warmer months in this region. During this period both the host and the mite multiply rapidly while during the winter months, November to Febru-

ary, the population of the house flies decreases considerably and not even a single parasitized fly was observed.

The maximum number of the mite observed on a single house fly was 24 and minimum 8. Usually all the mites occurred gregariously sucking the fluid of the host body. The most preferred feeding point was the bases of hind coxae. Besides this, the other attacked parts of the host are, wing axillaries, head haustellum, arthrodial membrane of the tergites and sternites of the abdomen.

Previously, Roy and Brown (1970) observed *Pyemotes ventricosus* Newport causing dermatitis in human being. In view of this, the present *Pyemotes* sp. of mite parasitizing the house fly may cause dermatitis in man as it can be easily transferred by the host insect.

We are grateful to the Commonwealth Institute of Entomology, London, for the identification of mite and to the authorities of M. S. College, Saharanpur, for providing facilities.

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ROY, D. N. & BROWN, A. W. A. (1970): Entomology (Medical and veterinary), p. 567. The Bangalore Printing and Publishing Company Ltd.

26. PREDATORY ANTS OF THE MOUND BUILDING TERMITE, *ODONTOTERMES WALLONENSIS* (WASMANN) WITH SPECIAL REFERENCE TO THE PREDATORY BEHAVIOUR OF *LEPTOGENYS PROCESSIONALIS* (JERDON)

INTRODUCTION

Termites have many enemies including both invertebrates and vertebrates. Among the invertebrates the best known predators are ants which prey on all stages of termites. They capture termites at the time of swarming, foraging and construction and expansion of their nests. From India Mathur (1962) has listed the following species of ants as enemies of termites *Acantholepis fravenfeldi* Mayr, *Camponotus compressus* Fab. (Formicinae); *Crematogaster* sp., *Monomorium destructor* Jerd., *M. indicum* Forel, (Myrmicinae) and *Leptogenys diminuta* Smith (Ponerinae). Negi (1934) reported *Leptogenys processionalis* as an active predator of termites.

Wheeler (1936) reported that several species of ants attack termites in the colonies and deplete and destroy the population. He recognised four categories of predatory ants.

1. Cleptobiotic ants : Ants which attack other ants and wrest their prey from them.

2. Termitolestic ants : Ants which live in the walls or partitions of the nests of termites and prey on them.
3. Inquiline ants : These ants are extremely aggressive. They occupy portions of inhabited or abandoned mounds.
4. Termitharpactic ants : Ants such as Ponerines, Dorylines and Myrmicines. They habitually raid colonies of termites which constitute a large proportion of their food.

The available reports on predatory ants of termites are scanty though of general interest. An attempt has therefore been made to investigate the various species of ants associated with termites.

Material and Methods

Observations were made on the various species of predatory ants at the Campus of the University of Agricultural Sciences, Hebbal, during 1976-78. Field visits were made periodically to the foraging sites and mounds of *Odontotermes wallonensis* and also to light sources during the monsoon season, to record the different species of ants. The predatory activity of *Leptogenys processionalis* was observed regularly during the summer (February and March) and the monsoon (July and August) seasons of 1978, by visiting the study site both in the mornings (between 0700 h to 1100 h) and in the evenings (between 1630 h to 2100 h). However, counts were made only during the morning hours. The total number of workers returning with termites was recorded at the nest. The enumeration, in each case, was performed continuously for 5 minutes using a tally counter. The correlation between the predatory activity of ants and weather factors has been worked out and presented in Tables 1 and 2.

Results and Discuission

During the present investigation the following ant species were encountered as predators of *Odontotermes wallonensis.*

Formicidae

I. Ponerinae
1. *Diacamma rugosum* (Le Guillou)
2. *Leptogenys laeviceps* (F. Smith)
3. *Leptogenys processionalis* (Jerd.)

II. Formicinae
4. *Anoplolepis longipes* (Jerd.)
5. *Camponotus rufoglaucus* (Jerd.)
6. *Camponotus sericeus* Fab.
7. *Oecophylla smaragdina* Fab.

III. Myrmicinae
8. *Crematogaster hodgsoni* Forel
9. *Leptomyrmex quadrispinosus* Jerd.
10. *Monomorium floricola* Jerd.
11. *Monomorium latinode* Mayr
12. *Myrmicaria brunnea* Saunders
13. *Solenopsis geminata* Mayr
14. *Tetramorium smithi* Mayr

IV. Pseudomyrmicinae
15. *Tetraponera rufonigra* (Jerd.)

V. Dolichoderinae
16. *Tapinoma melanocephalum* Fab.

These species of ants attacked those termites which emerged from their mounds or were engaged in activities such as foraging and nest construction under the conditions prevailing in Bangalore. The Ponerine ant, *Leptogenys processionalis,* was found to be an important predator of this species throughout the year. However, with the onset of the monsoon, the activity of this ant reached a peak. With the coming of rains, termite activities, like construction and expansion of the nest, food collection and alate emergence, reached a peak. It is a common sight to see moving columns of these ants fanning out at the foraging arena, in fields and grasslands, and along and across footpaths and roads. In the morning they are active between 0700 h to 1100 h. While in the evenings they are active between 1630 h

to 2100 h. On summer evenings their activity could extend upto 2300 h.

Initially, when searching for prey, these ants move in single file. Once they encounter the earthen sheathing of the termites they fan out in all directions. The ants first confirm the presence of termites by tapping their heads on the earthen foraging runways. They then proceed to find weak points in the runways. Once the walls are breached at these points, they start attacking the termites by producing a "hissing" sound. Mukerji (1931), reported that *L. pequeti*, a related species, too moved in files and made stridulatory sounds audible at a distance. Intense, continuous fighting was observed between the ants and the termite soldiers until the ants ultimately over-powered the termites by holding them in their mandibles

TABLE 1

PREDATORY ACTIVITY OF *L. processionalis* ON *Odontotermes wallonensis* DURING FEBRUARY-MARCH 1978 AT HEBBAL CAMPUS

Date of observation	No. of ants returning from the foraging site/5 min.	No. of ants carrying termites	Per cent predators	Distance from nest to foraging site (in meter)
3-2-78	95	61	64.21	20
4-2-78	187	52	27.80	16
6-2-78	217	71	32.71	12
7-2-78	198	87	43.93	10
8-2-78	61	20	32.78	9
9-2-78	236	121	51.27	15
10-2-78	119	92	77.31	14
12-2-78	191	83	43.45	10
13-2-78	182	98	53.84	10
14-2-78	282	116	41.13	13
15-2-78	394	144	36.54	9
17-2-78	302	112	37.08	10
21-2-78	145	54	37.24	12
22-2-78	165	49	29.69	11
23-2-78	211	86	40.75	8
24-2-78	307	157	51.14	14
26-2-78	392	66	16.83	15
28-2-78	108	1	0.92	18
8-3-78	265	115	43.39	16
14-3-78	210	95	47.26	9
15-3-78	112	54	48.21	19
Total	4379	1734	857.48	270
Range	61 to 394	1 to 157	0.92 to 77.31	9 to 20
Mean with standard deviation	208.53±90.98	82.58±38.39	48.84±15.85	12.86±3.56

21 observations from 3-2-1978 to 15-3-1978.

and stinging them with arched abdomen. Thus paralysed, they carried the termites positioned between their legs and clasped between clenched mandibles, back to their nests. The number of columns was dependant on the abundance of the available food.

When termite mounds were exposed thousands of these ants appeared suddenly and attacked the workers and nymphs of the termites. In a few weak termite colonies, the ants exterminated the colonies totally and occupied the mounds. Ant nests were also observed on the surface and in the vicinity of mounds. A maximum of ten ant nest openings were observed on the surface of a single mound.

The predatory behaviour of *L. processionalis* was observed during February and March 1978. The extent of predation is presented in Table 1.

Percentage predation of *L. processionalis* was worked out by counting both the total number of workers returning to the nest and the number of workers with termites returning to the nest. The per cent predation was found to vary from 0.92 to 77.31 per cent with an average of 40.84 ± 15.85 per cent.

When termites were available in plenty, the species concentrated only on them. *L. processionalis* was active throughout the year. They were more active in the monsoon season with their activity declining to a minimum during the summer season. They were particularly active on days preceded by rains as this coincided with alate emergence and nest expansion by termites.

In July, in one instance, the distance between the ant nest and the foraging site was found to be 15 cm and they were active from 0900 h to 1300 h. In the month of August similar activity was observed between 0800 h to 1000 hr. The number of ants transporting termites to their nest was 9990 in 4.5 h. in July (Average rate of predation being 37 termites per

TABLE 2

EXTENT OF ANT PREDATION AS INFLUENCED BY WEATHER PARAMETERS DURING THE SUMMER (FEB.-MARCH) SEASON OF 1978, AT HEBBAL.

	Temperature		Relative humidity	
	Maximum	Minimum	Morning	Evening
1. No. of ants returning from the foraging site	+ 0.0587	– 0.3191	+ 0.0971	+ 0.0665
2. No. of ants carrying termites	+ 0.0814	+ 0.1398	+ 0.2902	– 0.4489*
3. Percent predatism	+ 0.1227	+ 0.5073*	+ 0.4620*	+ 0.1997

	No. of ants returning from foraging site	No. of ants carrying termites	Per cent predatism
1. Distance from the nest to the foraging site	– 0.2298	– 0.2571	+0.0087
2. No. of ants carrying termites	+ 0.7011**	—	+0.4882*

n = 21 Correlation co-efficient values at 5% and 1% at
n = 21 are 0.423 and 0.537 respectively.

minute) and 3132 in 2 h in August (The average rate of predation being 26 termites per minute).

The inter-relationship between the predatory activity of ants and the weather parameters, like temperature and humidity, during 1978, is presented in Table 2. Maximum temperature did not significantly influence the foraging behaviour of ants, whereas minimum temperature appeared to influence negatively the population of ants returning from the foraging site, while it has a positive influence on per cent predation. This indicates that lower temperature increase predation of termites by ants, perhaps because lower temperature causes more movement of termites for foraging. This helps in ants being attracted to the foraging sites. Likewise, predation is positively influenced by relative humidity in the morning hours perhaps because the termites forage during the cooler hours, in humid weather.

The number of ants carrying termites decreased with increasing distance between the nest and the foraging arena as is evident from the negative relationship in Table 2.

C. sericeus, A. longipes (Formicinae) and *D. rugosum* (Ponerinae) attacked the termites at the time of mound construction and alate emergence during the night. They attacked those alate forms which had dropped their wings by basal fracture. These were also found nesting in the peripheral region of mounds. *O. smaragdina* was observed more in the foraging sites of termites, on grass and trees.

Among the other species of ants, *C. hodgsoni* and *I. rufonigra* were found associated with termites when the nest was exposed. The nests of *C. hodgsoni* were noticed in the upper regions of the mound, and measured 3 × 5 cm in diameter. Although *T. smithi* prey on termites they were not found to directly attack the termites but seemed to prefer wresting their prey from other ants.

Tapinoma melanocephalum, the only species under Dolichoderinae was observed quite frequently in large numbers and were found attacking the exposed nymphs and workers and termites. During the current period of study, only in ten cases were these ants found to be dragging the alate reproductives of termites to their nests by holding on to their wings.

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27. *AMARANTHUS VIRIDIS* (DESF.) A NEW HOST PLANT OF HADDA BEETLE, *HENOSEPILACHNA VIGINTIOCTOPUNCTATA* (FAB.) (COLEOPTERA: COCCINELLIDAE)

The hadda beetle, *Henosepilachna vigintioctopunctata* (Fab.) is one of the important species of phytophagous coccinellids causing damage to vegetable crops. It is a serious pest of several solanaceous and cucurbitaceous crops like brinjal, tomato, potato, gourds, melons and cucumbers. The pest has also been recorded on *Solanum nigrum* Linn., *S. xanthocarpum* Schard; *Datura indica* Linn. and *Withania somnifera* (Link).

During the 3rd week of August, 1983 *Chaulai* plants (*Amaranthus viridis*) which grew near *Solanum nigrum* plants were found to be infested by the *hadda* beetle at village Jangpur in district Ludhiana (Punjab). The leaves of A. *viridis* had characteristic feeding injury and both the grubs and the pupae were found on the leaves. The grubs of this beetle were brought in the laboratory and reared at room temperature, on leaves of *A. viridis* confined in glass jars (10 × 15 cm). The adults emerged successfully in a fortnight. *A. viridis* seems to be a new host plant of *H. vigintioctopunctata.*

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28. NEW RECORD OF *EYLAIS* SP. AND *ARRENURUS* SP. OF MITES PARASITIZING THE DAMSEL FLY

(*With a text-figure*)

Parasitic mites are of considerable economic importance and their larval stages are usually parasitic also. Their host range extends from insects to mammals. During the course of a survey of the aquatic fauna of the ponds of Saharanpur region, I came across two new parasitic mites parasitizing the damsel flies (Odonata — Zygoptera — Megapodegridae). The first mite is a species of genus *Eylais* (Acarina — Eylaidae) and the second of the genus *Arrenurus* (Acarina — Arrenuridae). The larvae of *Eylais* sp. are dark green in colour and those of *Arrenurus* sp. are bright red. Larvae of both the species of mite infest the wing axillaries, ventral part of the thorax and neck region of the host. Maximum number of mite larvae have been found near the wing articulation points of fore and hind wings (Fig. 1). The data of the infestation are presented in the Table.

Maximum number of mites recorded on a single damsel fly was 25 and minimum 1. Furthermore, percentage of parasitization extends from 13.46 to 27.02. Infested flies are

TABLE

SHOWING THE NUMBER OF INFESTED DAMSEL FLIES AND PERCENTAGE OF PARASITIZATION.

Date of the survey	No. of damsel flies caught	No. of infested flies	Part of infestation	Total No. of mites	Percentage of infestation
2nd July, 1980	40	6	W+S	30	15.00
16th Aug., 1980	35	5	W+S	31	14.28
12th Sept., 1980	52	7	W+N	28	13.46
15th July, 1981	38	8	W+N	32	21.05
4th Aug., 1981	42	11	S+W	49	26.19
5th Oct., 1981	29	4	W	12	13.79
17th July, 1982	44	8	D+W	39	18.18
21st Aug., 1982	28	5	N+W	27	17.85
2nd Sept., 1982	37	10	S+N	31	27.02

W — Wing bases, S — Sternites, N — Neck, D — Dorsum.

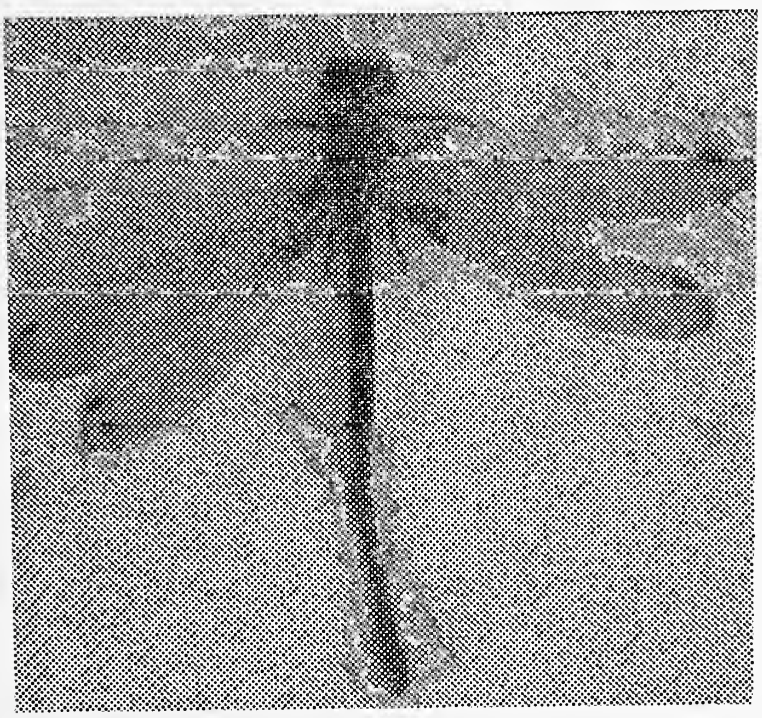

Fig. 1. Photograph of damsel fly showing the parasitization of *Eylais* sp. of mite at the wing bases.

available only during the rainy season in this locality, i.e., July to September. The time also coincides with the breeding season of both the mites and the damsel flies. Adults of both the species of mites have been collected from the bottom of six ponds situated at a distance from Saharanpur. Two infested flies were collected sitting on the wall of my house below a fluorescent tube (40 w) at night. Earlier, *Arrenurus* sp. have been reported attached to mosquito larvae and pupae (Roy and Brown 1970). Damsel fly is a new host record for both the mite species.

I am obliged to the Commonwealth Institute of Entomology, London, for the identification of the mites and to Dr. G. D. Garg for encouragement.

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29. A NEW COMBINATION IN *ASPIDOPTERYS* JUSS. (MALPIGHIACEAE)

Haines (1920) described *Aspidopterys hutchinsonii* as a new species closely allied to *A. obcordata* Hemsl. *A. hutchinsonii* is also closely allied to *A. tomentosa* (Bl.) Juss. In 1928 Niedenzu found that the distinctions between *A. tomentosa* and *A. obcordata* are not sufficient to treat them as separate species. He united these two and treated *A. obcordata* as a variety of *A. tomentosa* and proposed the new combination. Jacobs (1955) supported the view of Niedenzu (1928) and added another variety, *viz. A. tomentosa* var. *longirostris* (Arenes) Jacobs. The present studies on *A. hutchinsonii* have revealed that its distinction from *A. tomentosa* is not sufficient enough to treat it as a distinct species but are only just enough for a varietal status. Hence, the following new status and combination is proposed.

Aspidopterys tomentosa var. **hutchinsonii** (Haines) Srivastava, *status et comb. nov.* *A. hutchinsonii* Haines in Kew Bull. 1920 (2): 67-86. 1920.

Stout climbers. Branches sub-woody, rough due to bases of fallen hairs; twigs tomentose. Leaves orbicular, 7-12 × 6-11 cm, suddenly cuspidate, bases straight or rounded, densely silky hairy beneath, coriaceous; petioles *c.* 15 × 3 mm, rusty hairy. Panicles short, lateral, brown tomentose. Pedicels *c.* 1.2 cm long, articulated at *c.* 3 mm near the base, glabrous above articulation (in fruit). Sepals dorsally hairy; petals oblong, *c.* 3 mm long, glabrous. Samaras membranous, broadly elliptic to orbicular, 1.3-1.5 cm in diam etc, retuse at apex, cristate at nucleus on dorsal wing, cristate 5-7 × 1-2 mm, corpophores 3-4 mm long.

Fls.: Dec.-Feb.; *Frts.*: April-June.

Distribution: INDIA: Orissa, Mayurbhanj hills (2000-3000 ft.).

Representative specimen: Orissa: Mayurbhanj hills, Bhajam (2000 ft.), *Anonymous*, s.n. (DD 85846).

KEY TO THE VARIETIES OF *A. tomentosa* (BL.) JUSS.

1a. Leaves elliptic-obovate. Samaras ovate, 3.0-4.0 × 2.5-3.0 cm.
  2a. Leaf top shortly narrowed to rounded.... .... *tomentosa*
  2b. Leaf top truncate to emarginate, if emarginate the top protruding from a wide apical sinus giving the leaf three topped appearance . . ..*obcordata*
1b. Leaves orbicular or ovate-elliptic. Samaras suborbicular to orbicular or broadly elliptic, 1.3-2.5 cm in diam.
  3a. Leaves ovate-elliptic. Carpophores *c.* 5-7 mm long .... *longirostris*
  3b. Leaves orbicular. Carpophores *c.* 3-4 mm long. .... *hutchinsonii*

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30. A NEW VARIETY OF *HUMBOLDTIA UNIJUGA* BEDD. (CAESALPINIACEAE) FROM SOUTH INDIA

(*With ten text-figures*)

Humboldtia unijuga Bedd. var. **trijuga** Joseph & Chandrasekaran, var. nov.

H. unijuga Bedd. var. *unijuga* affinis, sed foliolis 3-jugis (maxime raro 2- vel 4-5 jugis) ad invicem 1-jugis et staminodiis 5 ad invicem nuliis, praecipue differt.

Holotypus. Trivandrum Dist., Koviltherimalai, 2-10-1973, *Joseph* 44511 (CAL). Isotypi *Joseph* 44511 (MH-num. acc. 85902, 85903, 118572, 118573, 118574). Paratypi: Trivandrum Dist., Koviltherimalai, 25-8-1975, *Joseph* 55994 (MH-num. acc. 118575, 118576, 118577, 118578).

Allied to *H. unijuga* Bedd. var. *unijuga* but differs mainly in the leaflets being three paired (very rarely two or four to five paired) instead of one paired and in having five staminodes instead of none.

Trees 10-15 m high; trunk 15-20 cm in diam.; bark greyish brown; branches slender, spreading, branchlets terete, nodes not constricted. Leaves paripinnate, usually with three pairs of leaflets (rarely two or four to five pairs), stipulate; main rachis up to 8.5 cm long with a swollen pulvinous, very narrowly winged between the leaflets. Leaflets 5.2-17.5 × 1.6-5.0 cm, sessile or subsessile, vary in size and shape, lanceolate, oblanceolate, elliptic to oblong, coriaceous, glabrous above, glabrescent below, abruptly acuminate at apex, unequal and oblique at base; main nerves up to 11 pairs forming intra-marginal loops, prominent on lower surface; midrib swollen at base below, more or less warted. Stipules up to 3.2 × 1.1 cm, erect, united along the auter margin about half of its length, lanceolate, oblique at base, bereft of appendage (spur). Flowers bright pink, in fascicles or in very short racemes from tubercles of main trunk or axillary from leafy branchlets, not wide opening. Bracts ± 2.0 × 1.2 mm, ovate, pubescent, acute. Pedicels up to 1.75 cm long, slender, pubescent. Bracteoles two, ± 10 × 7 mm, free, obovate to oblong, pubescent outside, glabrous inside except at base and margins, concave, obtuse to sub-acute. Calyx with a short tube (± 5 mm); lobes four, 8.0-13.0 × 5.0-10.0 mm, imbricate, unequal, elliptic-oblong to obovate, pubescent outside, sparsely puberulous inside, obtuse or subacute. Petals five, each 12.0-17.5 × 7.0-13.0 mm, pink, obovate, glabrous outside, sparsely puberulous at base within, abruptly obtuse to sub-acute at tip, shortly clawed at base. Stamens five, ± 2 cm long, alternating the petals, exerted; filaments bright pink, glabrous except at base; anthers ± 4 mm long, oblong, versatile; staminodes five, minute (± 1 mm long), erect, glabrous and acicular at tip, densely pubescent and pinkish at base. Disc densely pubescent. Ovary ± 8 mm long, stipitate, pubescent; style ± 1.8 cm long, glabrous above, pubescent at base; stigma capitate. Immature pod 6.0-10.5 × 1.0-2.5 cm, oblong, oblique, puberulous, compressed with persistent stylar beak. (Figs. 1-10).

The holotype *Joseph* 44511 (CAL) and isotypes *Joseph* 44511 (MH. Acc. Nos. 85902, 85903, 118572, 118573, 118574) were collected at Koviltherimalai, near Bonaccord Estate, Trivandrum District, Kerala on 2-10-1973; and paratypes *Joseph* 55994 (MH. Acc. Nos. 118575, 118576, 118577, 118578) were collected from the same locality on 25-8-1975.

Figs. 1-10: *Humboldtia unijuga* Bedd. var. *trijuga* Joseph & Chandrasekaran, var. nov. 1. Twig 2. Stipule with a portion of twig. 3. Bract. 4. Bracteole. 5 & 5a. Calyx lobes. 6. Petal. 7. Stamen. 8. Staminode. 9. Gynoecium with disc and staminodes. 9a. L. S. of Gynoecium. 10. Immature pod.

This graceful tree occurs in the forest at Koviltherimalai, near Bonaccord Estate in Trivandrum District at an altitude of about 875 m.

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SHILLONG 793 003.

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31. *SWERTIA SIKKIMENSIS* BURKILL (GENTIANACEAE): A LITTLE KNOWN PLANT FROM UTTAR PRADESH, INDIA

(*With seven text-figures*)

Swertia sikkimensis is described by I. H. Burkill in the year 1906 based on the collections of several specimens gathered from Sikkim, Bhutan and Himachal Pradesh. This plant usually occurs in the alpine Himalayas of Sikkim (Jongri, Tonglu, Phalut, Lachen and Lachung valley, Gaigong and Kinchinjhow etc.) ranging from 4112-5181 m (13, 500 ft. — 17,000 ft.). From Bhutan (Kungmet) it has once been collected so far by Dungboo in 1884. In Himachal Pradesh it has once been collected from Kunawar (Kinnar) by Nathaniel Vicary in 1831.

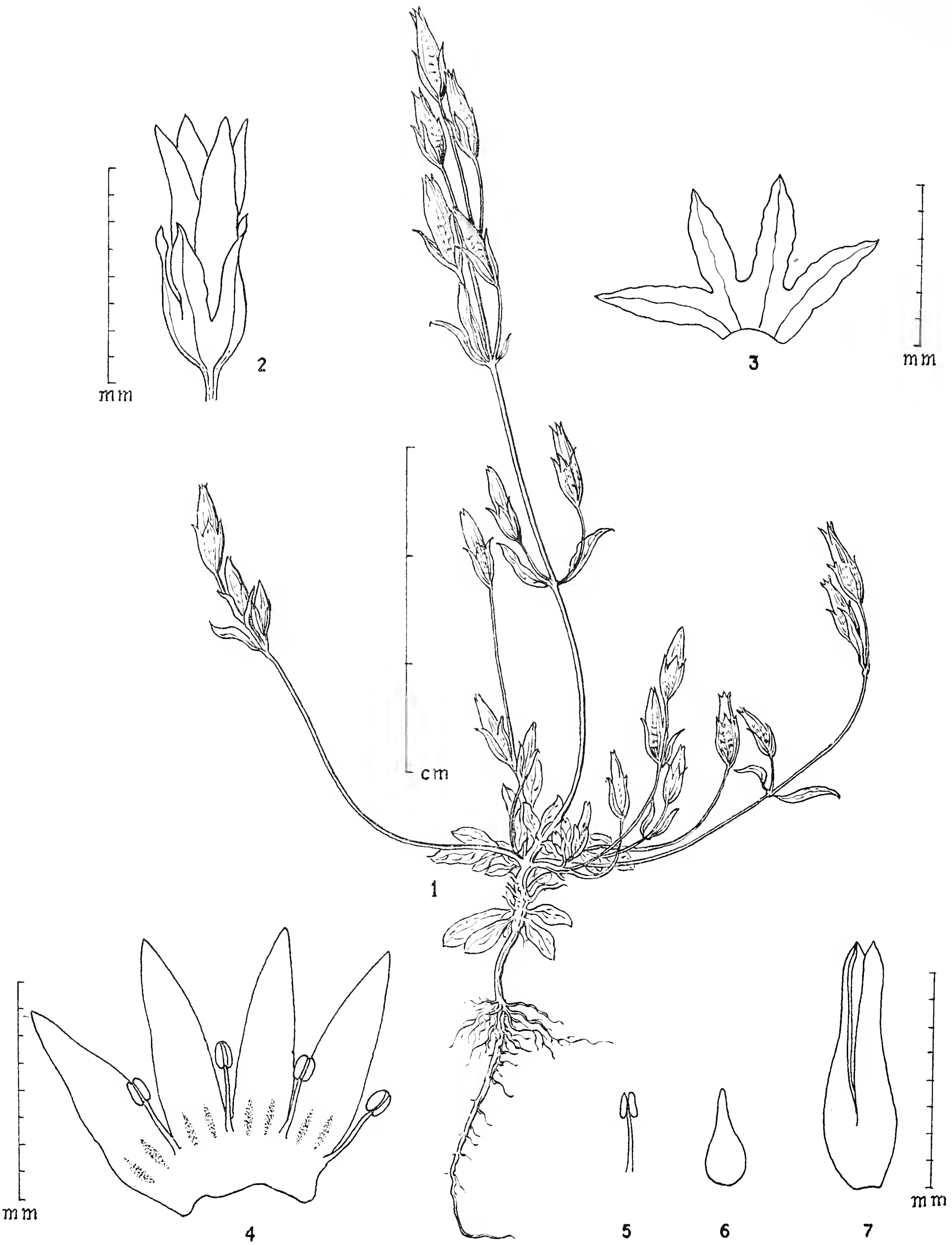
But after its first description it has not been collected from any of the areas mentioned. It is hitherto unrecorded from Uttar Pradesh, India and Nepal. Hence the present collection of this plant from Pithoragarh District (Kumaon), Uttar Pradesh, appears to be a new record. Moreover, this plant has been collected again after a long gap of about 70 years.

The distribution of this plant in Nepal is expected as both Sikkim and Kumaon are adjacent to East Nepal and West Nepal respectively. Moreover, the present collection locality is very close to West Nepal bordering the River Kali.

It is described here again with an illustration as there is no further information except the original one.

Swertia sikkimensis Burkill in J. Asiat. Soc. Bengal, *n.s.* 2: 322. 1906. (Figs. 1-7).

Annual herb of 4-12 cm high, usually branched at base, glabrous. Leaves subsessile to shortly petioled, lower ovate to spathulate, 5-9 × 3-4 mm, upper lanceolate 4-10 × 1.5-3 mm. Inflorescence both axillary and terminal raceme. Flowers mostly 4-merous rarely 5-merous. Calyx cyathiform, lobes oblong-lanceolate, 3-4 × 1-1.5 mm, slightly alternately heteromorphic. Corolla lobes oblong lanceolate, 5-8 × 1.8-2.5 mm, bluish-green; glands obscure, two on each petal, linear-vertical, placed towards the base, one on either side of mid-vein. Capsule oblong, 6-9 × 2-2.5 mm,



Figs. 1-7. *Swertia sikkimensis* Burkill
1. plant, 2. flower, 3. calyx split open, 4. corolla split open, 5. stamen, 6. carpel and 7. capsule.

dehiscence about one-third of the total length of capsule. Seeds 10-15 in each capsule, ellipsoid, testa reticulate, purple-red.

This plant grows in shady moist places along with *Swertia ciliata* (G. Don) Burtt, *S. cordata* (G. Don) C. B. Clarke and other *Gentians.*

Sheets examined: (all are deposited at CAL).

Sikkim: Thangu, Sept. 1903, *Prain s.n.*; Giagong, Sept. 1903, *Prain s.n.* (Syntype);

Bhutan: Kungmet, 3.8.1884, *Dungboo* 295 (Syntype);

Himachal Pradesh: Kunawar, 1831, *N. Vicary s.n.* (Syntype);

Uttar Pradesh: Kumaon, Pithoragarh Dist., Kutti valley, Garbyang to Chhalek, 3124 m, 26.10.1976, *G. G. Maiti* 844; Kutti valley, Chhalek to Budhi village, 2800 m, 26.10.1976, *G. G. Maiti* 852 and Byans, Sirkha to Rungling forest, 2500 m, 13.10.1976, *G. G. Maiti* 367.

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32. *EUPHORBIA TORTILIS* ROTTL. EX WIGHT — A NEW RECORD FOR KARNATAKA

Euphorbia tortilis Rottl. *ex* Wight was recorded in India only from Tamil Nadu. During collection trips to different parts of Mysore and Mandya districts of Karnataka, we noticed this plant in several places along hedges. The species closely resembles *E. antiquorum* L. and has often been confused with the latter. However, *E. tortilis* can be distinguished from *E. antiquorum* in having spirally twisted stems and crowded cymes. It is quite likely that *E. tortilis* occurs at many more localities on the Deccan Plateau. A brief description of the taxon is given below:

Euphorbia tortilis Rottl. **ex** Wight Ic. t. 898. 1844-45; Hook. f., Fl. Brit. India 5: 256 1887; Gamble, Fl. Madras Rep. ed. 2: 894. 1957.

An erect shrub with abundant milky latex, up to 2.4 m high. Main stem cylindric or angled; branches thick, green, fleshy, jointed; joints 3- to 5-winged, up to 25 cm long, spirally twisted; wings compressed, coarsely repand-crenate, with pairs of sharp stipular spines; spines *c.* 6 mm long. Leaves minute, ovate. Cyathia in cymes of 3, shortly peduncled and forming clusters in the sinuses, *c.* 4 mm in diameter, green, with 5 large glands; bracts minute, ovate; bracteoles numerous, fimbriate. Male flowers many. Styles 3, shortly connate at base, 2-lobed, glabrous. Fruit *c.* 13 mm in diam., glabrous; cocci keeled.

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33. GENUS *TYPHA* IN THE NORTH WESTERN HIMALAYAS

Typha, a highly variable genus, is distributed in Asia, Europe, Africa, Tropical Australia, South and Central California with about 13 existing and 2 fossil species. It is represented by 3 species in the Kashmir Himalayas. All the species are economically very important. They are valued as ornamental plants on the borders of ponds, pools and irrigation canals.

In Kashmir all the species of *Typha* are cultivated for the preparation of floating islands as prevention against erosion, however, caution needs to be exercise to control them lest they should multiply excessively.

Dry fruiting spikes are used for decoration. The strong fibrous culms or leaves are used in weaving mats and basket work. The fine plush got from the hairs of female spike were used in the stuffing of pillows, but the practice has been discontinued. The hairs of female spike locally called *kalroon* mixed with mud is used for plastering walls, which gives smoothness to it and forms an excellent base for paint work. The leaves are mainly used for the weaving of mats (*wagoove*) and prayer rugs; the peduncle is used in the preparation of window curtains. The stems and leaves are also used for thatching huts and house boats.

KEY TO THE SPECIES

1. Male and female spikes not contiguous; usually separated by 1-3 cm interval. Leaves flat above, convex beneath, 13 mm wide .... *T. angustata*
1. Male and female spikes contiguous, not separated. Leaves narrow slightly channeled; wavy margined above the middle, less than 13 mm wide
   2. Plants more than 2 m long; stigma ovate-lanceolate or spatulate .... *T. elephantina*
   2. Plants less than 2 m long; dwarf; stigma subobtuse .... *T. laximannii*

Typha angustata Borry and Chaub. Exped. in Bory Sci. Mores 3: 338 (1832); Hook. f. Fl. Brit. Ind. 6, 489 (1893); Graebner, in Pflanzenr. 2: 14. f. 4F, (1900); Subramanyam, Aq. Angios. 74 (1962).

In the field it can be readily distinguished by its very long, erect leaves and the dense monoecious interrupted spicate inflorescence, fuzzy brown at maturity. Leaves sheathing at the base, conspicuously auriculate; auricles scarious. Stigma fleshy; ovary linear or linear oblong; sterile ovaries cuneate with a rudimentary style on the truncate flattened apex; the hairs on the stipe are in whorls terminating into a club-shaped or ligulate tips. Fruits obconical or fusiform, 1 mm long, tapering into the stalk.

Common in marshes, shallow waters of lakes; along streams and sides of irrigation canals; Nagin lake AMK 3732; Hokhar sar AMK 3944; Dal lake AMK 3888.

Distribution. Asia, Europe, Africa, Himalayas, Kashmir.

Typha elephantina Roxb. Fl. Ind. 3: 566

(1832); Hook. f. l.c. 481; *T. latifolia* Edgew, Proc. Linn. Soc. 6. 194 (1862).

Superficially resembling *T. angustata* but can be distinguished from it in having male and female spikes contiguous; mature female spikes much longer and thicker; stigma ovate-lanceolate or spatulate; sterile ovaries ellipsoid, tipped at the round apex by a rudimentary style. Fruit cylindrical.

Mostly in the marshes, on the banks of lakes; Dal lake AMK 3733; Nagin lake (near Nandpora) AMK 3829; Hariparbat (inside) Fort AMK 3946.

Distribution. Asia, Europe, America, Himalayas, Kashmir.

An anamalous form of the species with 2-4 pistillate spikes arising from a common stalk, with a single terminal staminate spike was found growing near Habak, Dal lake and Harwan (Srinagar). This anamalous spike showed no other morphological difference with the normal *T. elephantina* Roxb. regarding vegetative and floral characters and this seems to be conspicuous anamalous feature for the species and its frequency of occurrence was in no way less than that of the normal *T. elephantina* Roxb. It was also observed that the normal species grows under similar micro-climatic conditions at various spots within this altitudinal range.

Typha laximannii Lepech. in Nva. Acta Petersh 84: 355 (1801); Hook. f. l.c. 6. 586.

Rhizomatous perennial herbs, can be differentiated from the other two species in being smaller in size, leaves distichiously arranged equal or longer than spikes, sheathing at the base; male and female flowers usually contiguous; stigma subobtuse. Fruit 1 mm long, cylindrical.

Common in marshes; on the banks of the lakes; sides of the rice fields, Bemna AMK 3889; Shalteng AMK 3945.

Distribution. Russia, Pakistan, India, Kashmir.

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34. DISTRIBUTIONAL NOTE ON SOME INDIAN GRASSES

While working on the family Poaceae at Central National Herbarium we noticed a few grasses of doubtful identity. A critical study of these resulted in finding new distributional areas for the following grasses.

1. **Chrysopogon serrulatus** Trin.

This grass has been reported from NW India, Bihar and Nepal (Hara 1966). A specimen collected from Arunachal Pradesh and identified as *Chrysopogon fulvus* (Spreng.)

Chiov. has been identified as *C. serrulatus* Trin. due to the presence of cilia in the upper quarter of the upper glume. This extends the distribution of *C. serrulatus* Trin. to Arunachal Pradesh.

Exsicc. Arunachal Pradesh; Kameng Dist., Dahing, 3 Oct. 1964, *J. Joseph* 40469 (CAL).

2. **Ischaemum tumidum** Stapf ex Bor

This grass is known from Bombay (Old Bombay Presidency) and Tamil Nadu. A specimen collected from Sanchi and labelled as *I. kingii* Hook. f. has shorter pedicels and swollen raceme joints which identify the specimen to *I. tumidum* Stapf ex Bor. It is a new record for Madhya Pradesh.

Exsicc. Madhya Pradesh; Sanchi, Sept. 1907, *A. Meebold* 9124 (CAL).

3. **I. zeylanicolum** Bor

The known distribution of this grass is Bombay, Sri Lanka and Kerala (Nair & Ramachandran 1980). A recent collection from Humphreygunj extends its distribution to Andaman Islands.

Exsicc. Andamans; Humphreygunj, 23 Nov. 1973, *N. P. Balakrishnan* 631 (CAL).

4. **Lolium remotum** Schrank var. **aristatum** (Doell) Aschers.

This grass was first reported from India from localities in Himachal Pradesh and Uttar Pradesh (Bhattacharyya 1976). We noticed that a specimen identified as *L. temulentum* L. has weak flexuous awns and smaller spikelets and identify the specimen as *L. remotum* Schrank var. *aristatum* (Doell) Aschers, a new record for Rajasthan.

Exsicc. Rajasthan; Jaipur, 9 Feb. 1964 *S. Sharma* 406 (CAL).

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35. *ARTHROMERIS LUNGTAUENSIS* CHING: A NEW RECORD FOR INDIA

(*With four text-figures*)

Arthromeris, a small genus of polypodiaceous ferns (subfamily Crypsinoideae) has a very restricted distribution in North India, China, Burma and Bhutan. In all, thirteen species have been recognized by Ching and Tagawa (Christensen 1934, Pichi Sermolli 1965). Out of these six species have been reported from India (Beddome 1892, Tagawa 1966, Nayar & Kaur 1974). With the addition of a new species *A. jarretti,* from NEFA (Sastry & Chowdhary 1969) the number of species of *Arthromeris* in India rose to seven and in the world to fourteen. Recently during the course of a study of pteridophytic flora of Pithoragarh district of Kumaon (West Himalayas), *A. lungtauensis* Ching a species earlier known from China and Darjeeling in India has been recorded from Kumaon Himalayas for the first time. This species grows in moist shady places and the following description is based on plants collected from two localities near Pithoragarh town (P.W.D. rest house and enroute to Seloli village). The specimens are lodged in the herbarium of Botany Department, P. G. College, Pithoragarh.

A. lungtauensis Ching, Contr. Inst. Bot. Nat. Acad. Peiping *2*: 98, 1933: Icones Filicum Sinicarum, Fascicle 3, plate 150, 1935. Tagawa in Hara, Fl. East. Himal. 490, 1966.

Rhizome thick, stout, clothed with lanceolate, brownish paleae with entire or dentate margins. Fronds large usually upto 30 cm. long, stipes erect, 7-12 cm. in length, naked, brown in colour. Pinnae 1, 3 or 5 in number, opposite or subopposite, distantly placed, 8-10 cm. long; terminal pinna larger than lateral ones; lateral pinnae sessile, articulated to the rachis, lanceolate, coriaceous with cartilaginous entire and wavy margins, base cordate. Sori irregularly distributed on either side of midrib on under surface of lamina, sometimes very close to each other; paraphyses long with swollen heads. Spores yellow, bilateral, non perisporiate, spinulose, 50×28 μ.

A. lungtauensis differs from other species found in India in having (i) cordate base of the pinnae, (ii) irregular distribution of sori on under surface of lamina and (iii) presence of swollen headed paraphyses.

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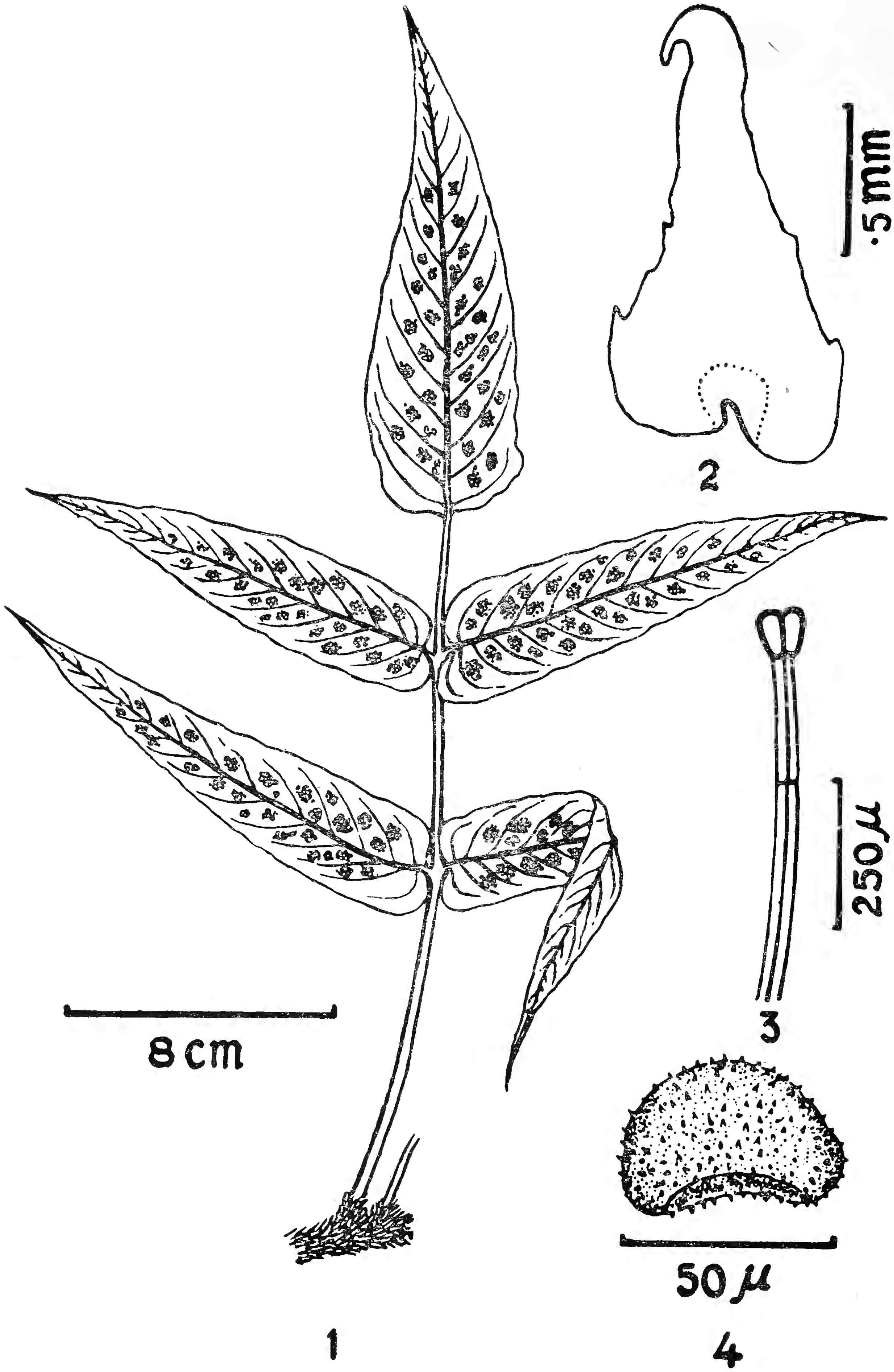

Figs. 1-4. *Arthromeris lungtauensis* Ching
1. Sporophyte showing habit. 2. Palea on the surface of the rhizome. 3. Paraphysis found in between the sporangia. 4. Lateral view of a spore.

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36. A NOTE ON PHYTOGEOGRAPHICAL DISTRIBUTION OF FERNS AND FERN-ALLIES OF ALMORA (W.H.)

Western Himalayan tracts have been explored extensively for pteridophytes from time to time by a number of workers (see Awasthi & Sharma 1980) but Almora, an important Kumaon area remained unexplored. This has necessiated a detailed investigation of pteridophytes of Almora situated at an altitudinal range of 1500 m to 2100 m. Mainly Almora proper and its suburbs which include Chitai, Kalimati, Simtola, Kasar devi, Ranidhara etc. were explored extensively.

The soil in this area is compact yellow to brownish black clay and is rich in magnesium salts. In the forests, ground floor is usually covered with a thick layer of humus formed by organic decay and thus provides a good substratum for the growth of terrestrial species. Conifers namely *Pinus roxburghii* and *Cedrus deodara* form an important part of the vegetation of this area. At Chitai, Kasar Devi and Kalimati pure stands of conifers are present. At other places intermingled with these are species of *Quercus, Rhododendron, Ficus, Eugenia, Bauhinia, Terminalia* etc. The ground flora consists mainly of *Anaphalis, Polygonum, Geranium, Pimpinella, Fragaria, Desmodium, Indigofera, Crotolaria* etc. The shrubs which are common in this area include *Berberis, Reinwardtia, Flemingia, Woodfordia, Rhus* etc.

In all 55 species of pteridophytes, 51 belonging to ferns and 4 to fern allies have been collected from this region (see Table 1). *Lycopodium cernuum* Linn., which was found growing on dry exposed slopes is an interesting species. It has not been reported earlier from western Himalayas, though it has been reported by Mehra & Bir (1964) from eastern Himalayas. *Botrychium daucifolium* Wall., is another interesting species which has been recorded earlier only from Garhwal region of western Himalayas by Awasthi and Sharma (1980). It was found growing on moist-shady slopes at Kasar Devi and Simtola. Other interesting species include *Lygodium flexuosum* (L.) Sw. (as climber on bushes), *Onychium siliculosum* (Desv.) C. Chr. (on moist-shady rocks), *Athyrium setiferum* C. Chr. (on moist-shady slopes), *Ctenitis hendersonii* (Bedd.) H. (on exposed dry rocks), *Oleandra wallichi* (Hook.) Presl. (on damp and shady slopes), *Abacopteris multilineata* (Wall.) Ching (along streams), *Cyclosorus megaphyllus* (Mett.) Ching (on the forest floor),

Pyrrosia mollis (Kze.) Ching (epiphyte on Oak tree), *Microsorium membranaceum* (D. Don) Ching (epiphyte on the lower part of the trunk of trees), *Arthromeris wallichiana* (Spr.) Ching (in moist and shady places), *Phymatodes hastata* (Thunb.) Ching (on exposed rocks), *P. malacodon* (Hook.) Ching (on tree trunks of *Quercus* and *Rhododendron*) etc.

The ferns and fern-allies which are met with in this area are also common in the adjoining hills. 58% species are common to Kumaon hills which include National and Ranikhet; 74.5% species are common to Garhwal Himalayas; 74.5% species are common to Himachal Pradesh hills which include Simla, Dalhousie and Dharamsala and 43.6% species are common to Kashmir himalayas. On regional basis, the phytogeographical distribution of these reveals that : (a) 78.1% species are common to eastern Himalayas; (b) 42% species are common to southern hills; (c) 22% species are common to central Himalayas (i.e. Pachmari). (d) 92% species are common to western Himalayas; (e) 76.3% species are common to both eastern and western Himalayas; (f) 21.8% species are met only in western Himalayas; (g) 1.9% species are met only in eastern Himalayas.

TABLE 1

Lycopodium cernuum Linn.
Selaginella chrysocaulos Hook & Grev.
S. chrysorrhizos Spr.
Equisetum debile Roxb.
Ophioglossum reticulatum Linn.
Botrychium lanuginosum Wall.
B. daucifolium Wall.
Lygodium flexuosum (L.) Sw.
Onychium japonicum (Thbg.) Kze.
O. siliculosum (Desv.) C.
O. contiguum (Wall.) Hope
Pteris quadriaurita Retz.
P. asperula J. Sm.
P. cretica Linn.
P. vittata Linn.
Cheilanthus farinosa (Forsk.) Kaulf.
C. albomarginata Clarke
Adiantum capillus-veneris Linn.
A. incisum Forsk.
A. philippense L.
A. venustum Don
Pteridium aquilinum (L.) Kuhn
Athyrium nigripes (Bl.) Moore
A. setiferum C. Chr.
Diplazium polypodioides Blume
Hypodematium crenatum (Forsk.) Kuhn
Dryopteris odontoloma (Moore) C. Chr.
D. sparsa Ham. ex. Don
D. chrysocoma (Christ) C. Chr.
Polystichum aculeatum (L.) Roth
P. squarrosum (D. Don) Fee
P. stimulans Presl.
Tectaria macrodonta (Fee) C. Chr.
Ctenitis hendersonii (Bedd.) H.
Nephrolepis cordifolia (Linn.) Presl.
Oleandra wallichii (Hook.) Presl.
Araiostegia multidentata (Bedd.) Copel.
Davallia trichomanoides var. *lorrainei* (Hance) Holtt.
D. bullata Wall.
Asplenium dalhousiae Hook.
A. ensiforme Wall.
A. varians Wall.
A. trichomanes Linn.
Abacopteris multilineata (Wall.) Ching
Ampelopteris prolifera (Retz.) Copel.
Cyclosorus megaphyllus (Melt.) Ching
Pyrrosia mollis (Kze.) Ching
Lepisorus nudus (Hook.) Ching
L. excavatus (Bory) Ching
Polypodium lachnopus Wall.
P. amoenum Wall.
Microsorium membranaceum (D. Don) Ching
Arthromeris wallichiana (Spr.) Ching
Phymatodes hastata (Thunb.) Ching
P. malacodon (Hook.) Ching

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37. NOMENCLATURAL NOTES ON SOME PLANTS FROM MAHARASHTRA

During our studies of the Flora of Sindhudurg district we have come across some plant names which need corrections with reference to the rules of 'International Code of Botanical Nomenclature'. In this communication, we have discussed the status of the names of three common endemic species from Maharashtra.

1. **Mammea longifolia** (Wight) Planch. & Triana, *in* Ann. Sci. Nat. Ser. 4, 15 : 240, 1861. *Calysaccion longifolius* Wight, Ill. 1 : 130, 1840 & Icon. t. 1999, 1844. *Ochrocarpus longifolius* Benth. *ex* T. Anders., *in* Fl. Brit. India 1: 270, 1874. *Calophyllum suriga* Buch. -Ham. *ex* Roxb., Fl. Ind. 2 : 608, 1832. *Mammea suriga* (Buch.-Ham.) Kosterman, *in* Comm. For. Res. Inst. Indonesia (Bogor) 72 : 23, f. 19, 1961; Santapau, in Bull. Bot. Surv. India 3 : 19, 1961.

Kosterman (1.c.) made a new combination, in genus *Mammea* Linn., based on Buchanan Hamilton's name *Calophyllum suriga* published by Roxburgh. Rev. Fr. H. Santapau adopted Kosterman's name for our common Indian species known by popular local name as "Surangi" and since then it has been used in Indian Floras as the correct name. However, we have found that the basionym of Kosterman's new combination is a superfluous name and has to be rejected. Roxburgh, in the protologue of his new name has cited *Calophyllum soulattri* Burm. f. as a direct synonym. According to Article no. 63[1] of ICBN, Roxburgh's name becomes an illegitimate name and should be rejected. The earliest valid name for the species is *Calysaccion longifolium* Wight. Since the genus *Ochrocarpus* Thouars is merged with *Mammea* Linn. the correct name for the species should be *Mammea longifolia* (Wight) Planch. et Triana.

2. **Embelia acutipetalum** (Lamk. *ex* Hasskarl) Comb. nov. *Basal* no. 1, Lamk., Encycl. 1: 381, 1783. *Basal acutipetalum* Lamk. *ex* Hasskarl, Hort. Malab. Rheed. clavis, 40, 1867;

[1] Article 63 states, "A name is illegitimate and is to be rejected if it was nomenclaturally superfluous when published, i.e. if the taxon to which it was applied, as circumscribed by its author, included the type of a name or epithet which ought to have been adopted under the rules."

Dauceria acuta Dennsted, Schllues Zum Hort. Malab. 31, 1818. *Embelia acuta* (Dennst.) Alston, in Trimen Handb. Fl. Ceylon 6 : suppl. 177, 1931. *Embelia tsjarium-cottam* (Roem. et Schult.) A. DC., *in* Wight Icon. t. 1209, 1848; Santapau, Fl. Khandala, ed. 3, 141, 1967. *Embelia robusta* auct. non Roxburgh, 1832; Brandis For. Fl. 2 : 284, 1874; Clarke, C. B. *in* Hook. f., Fl. Brit. India 3: 515, 1832; Cooke, T., Fl. Presid. Bombay 2: 85, 1904.

Embelia tsjarium-cottam A.DC. is the commonly accepted name for the species known in Maharashtra under vernacular name "Vauding" or "Waurung". Seeds of this species are collected and used in preparation in Ayurvedic medicines for anthelmintic purposes. Alfonse de Candolle made a new combination *Embelia tsjarium-cottam,* based on *Ardisia tsjarium-cottam* Roem. et Schult. (Syst. 4 : 518, 1819). Actually both of these names and also *Antidesma pubescens* Roxb. (Pl. Corom. Coast 2 : 35, t. 167, 1798) are based on "Tsjarium-cottam" of Rheede's figure, in Hortus Malabaricus (5 : 21, t. 11, 1688). Plants based on Rheede's above mentioned figure are now considered conspecific with an Euphorbiaceous species *Antidesma ghasembilla* Gaertn. (see also Cooke, T. l.c.). Therefore *E. tsjarium-cottam* A.DC. should not be used for our Myrsinaceous species. Rheede's text figure in Hortus Malabaricus (5 : 23, t. 12, 1688) 'Basal' (Besaal in plate) represents our species, which also cites vernacular name 'Vidingi'. In post-Linnean taxonomic works, Lamark was the first to use Rheede's 'Basal' for naming the plant. But unfortunately he did not use binomial system for the nomenclature. After Lamark, it was Dennstedt who named Rheede's 'Basal' as *Dauceria acuta* Dennst. But according to H. W. Rickett & F. A. Staflew (Taxon 10 : 80, 1961) and H. Manitz (Taxon 17 : 500, 1968) Dennstedt's name is nomen nudum. According to Article no. 41 of ICBN, the name of species is not valid if it is not published in combination with an already published generic name. According to Rickett & Staflew (l.c.) publication of genus and species which refers to pre-Linnean work does not constitute a valid publication. J. K. Hasskarl (Horti Malabarici Rheedeani Clavis Locuplectissima, 40, 1867) gives *Basal acutipetalum* Lamk., attributing the binomial to Lamark (Encycl. 1 : 381, no. 1, 1783). Since Lamark did not publish the actual binomial, the name *'Basal acutipetalum'* should be effective from 1867, and should be called *Basal acutipetalum* Lamk. *ex* Hasskarl. Therefore a new combination *Embelia acutipetalum* (Lamk. *ex* Hasskarl) comb. nov. is proposed.

3. **Olax psittacorum** (Willd.) Vahl, Enum. 34, 1804. *Fissilia psittacorum* Willd., Sp. Pl. 1 : 194, 1797. *Olax scandens* Roxb., Pl. Cor. 2:2, t. 102, 1798 & Fl. Ind. 1 : 164, 1832; Wight & Arn., Prodr. 89, 1834; Graham, Cat. Bombay Pl. 22, 1839; Masters, *in* Fl. Brit. India 1 : 575, 1875; Sleumer, *in* Pflanzenfam. ed. 2, 16B: 27, 1935; Santapau, Fl. Khandala, ed. 3, 38-9, 1967.

Fissilea psittacorum Willd., is the oldest name for the species which goes under the name of *Olax scandens* Roxb. in our floras. Vahl made new combination in genus *Olax* Linn., based on specific epithet *psittacorum.* Roxburgh, (*in* Fl. Ind. 1: 164, 1832) cites *Fissilea psittacorum* Willd. as a synonym under the *Olax scandens* Roxb. Index Kewensis lists *Fissilea psittacorum* Lamk., attributing specific epithet *psittacorum* to Lamark. However, Lamark did not publish the specific name *psittacorum.* He gave the diagnosis and the plate of genus *Fissilea* Comm. *ex* Juss. (Gen. 260, 1789) (see also Lamk., Illustr. Gen. 1 : 102, t. 28, 1791). Willdenow, (in Sp.

Pl. 1 : 194, 1797) named Lamark's plate and diagnosis as *Fissilea psittacorum* Willd. Therefore the specific name *psittacorum* should not be attributed to Lamark but to Willdenow. However, Blanco, (Fl. Filip. ed. 1, 28, 1837) used the name *F. psittacorum* for species presently known as *Olax wightiana* Wall. *ex.* Wight & Arn. and Masters (l.c.) has placed Vahl's name *Olax psittacorum* (Willd.) Vahl, in the synonymy of *Olax wightiana* Wall. as well as *Olax scandens* Roxb.

Roxburgh's identification of his own species — *Olax scandens* Roxb. — synonymous with *Fissilea psittacorum* renders his name superfluous and should be rejected.

Sleumer (l.c.) treats *O. scandens* Roxb. and *O. wightiana* Wall. as conspecific. Rev. Fr. H. Santapau (l.c.) keeps both these species as distinct, but seems to be in trouble while correctly placing his Khandala plants under the proper species. Even if we consider Master's view as correct in keeping them as distinct species, then *Olax psittacorum* (Willd.) Vahl should replace *Olax scandens* Roxb. According to Article no. 53 of ICBN, "When a species is divided into two or more species, the original specific epithet must be retained for one of them or, if it has not been retained, it must be reinstated for one of them."

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